AN OVERVIEW OF HOUSING CONDITIONS, CHARACTERISTICS AND EXISTING INFRASTRUCTURE OF ENERGY, WATER & WASTE SYSTEMS IN QUETTA, PAKISTAN

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ISBN 978-2-930909-11-0

Suggested Citation
Mahar, W. A., & Attia, S. (2018). An overview of housing conditions, characteristics and existing infrastructure of energy, water & waste systems in Quetta, Pakistan. *SBD Lab, University of Liège*, ISBN 978-2-930909-11-0

Edition 1 (Liège | April 2018)
http://hdl.handle.net/2268/222793

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Preface

This report is a part of the PhD project entitled “Methodology for the design of climate responsive houses for optimized thermal comfort in Quetta, Pakistan” being carried out at University of Liège, Belgium. The aim of the project is to improve indoor thermal comfort of free running houses in Quetta and raise the awareness of builders about climate sensitivity.

The present findings are based on the housing survey and the available literature regarding housing and existing infrastructure of energy, water & waste systems in Quetta, Pakistan. We aim to provide the readers with insights and perspectives on housing construction, conditions and characteristics in Quetta, Pakistan and existing infrastructure of energy, water & waste systems.

Acknowledgement

We would like to thank all the respondents who participated in the surveys, housing survey team which includes architecture student, faculty members of BUITEMS Quetta and professionals associated with building and construction industry.

We are greatly thankful to Mr. Ahmed Farooq Bazai (S.I), Vice Chancellor Balochistan University of Information Technology, Engineering & Management Sciences (BUITEMS) Quetta, Pakistan for his continuous support. We are also thankful to Prof. Dr. Griet Verbeeck and Dr. Elke Knapen from Hasselt University, Belgium for their input and guidance at various stages of this work.

The report is a part of the research grant provided under HRDI-UESTP Scholarship of Higher Education Commission (HEC) Pakistan.

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List of abbreviations

BB	Baked Brick
BUITEMS	Balochistan University of Information Technology, Engineering & Management Sciences
GoB	Government of Balochistan
H2H	House to House
HSR	High Service Reservoir
K-Electric	Karachi Electric
M.A. Jinnah	Muhammad Ali Jinnah
OHT	Overhead Tank
PBS	Pakistan Bureau of Statistics
PCC	Plain Cement Concrete
P&D	Planning & Development
PVC	Polyvinyl Chloride
QDA	Quetta Development Authority
QESCO	Quetta Electric Supply Company
RCC	Reinforced Cement Concrete
Rs.	Rupees
UGT	Underground Tank
UoB	University of Balochistan
WASA	Water & Sanitation Authority

Introduction and context

The city of Quetta is the provincial capital of Balochistan province and the 10th largest city of Balochistan with over 1 million urban population (PBS, 2017). It has a dry-arid climate with hot summer and mild to extreme cold in winter. The city also receives snowfall between the months of December, January, and February. Quetta is located outside of monsoon region so that it receives very less rain fall (P&D GoB, 2011).

This report is the part of a PhD project, which aims to improve the indoor thermal comfort of free running houses in Quetta. Unlike other major cities of Pakistan, the available data on housing in Quetta is very limited or outdated. For that it was necessary to start with a housing survey to understand the characteristics, materials, construction, and typologies of existing houses in Quetta. Furthermore, the information on the climate and the available systems for energy, water and waste is also included in this report.

Housing Survey

To find out the characteristics of existing housing a Housing survey was conducted to create an inventory of housing stock of Quetta. Since in recent year the law and order situation in Quetta is unsatisfactory (P&D GoB, 2011), considering this fact it was essential to know more about housing areas which are safe for students and staff to visit and conduct a housing survey. So, this survey includes two steps, first identification of safe areas and second conduct of housing survey.

1. Safety Questionnaire

A safety questionnaire was developed and distributed online via email and social networking apps to identify the safe areas.

1.1 Problem statement

The city of Quetta witnessed many terrorist attacks in recent years. Moreover, few of the residential areas are considered unsafe for people of specific ethnic or religious backgrounds. To consider the safety of survey team for housing survey it was necessary to find safe areas where students and staff can visit the houses and complete the survey.

1.2 Goal

To find out the safe areas of Quetta city to conduct housing survey

1.3 Research Questions

- Which are the most familiar areas of Quetta city?
- Which are the most familiar sub-areas of selected areas in Quetta?
- Which areas are considered safe in Quetta?

1.4 Methodology

The city of Quetta was divided in 11 areas (Figure **1**) with reference to the familiarity of local population with the major roads and links. Quetta cantonment and areas with less and scattered population were not included in this survey. The reason behind exclusion of Quetta cantonment. is to avoid difficulty in getting permission for visit. Additionally, cantonment authority does not follow the bylaws of city. These areas were further divided into several sub-areas. A safety questionnaire was developed and distributed online via email and social apps, i.e. Facebook, WhatsApp. Questionnaire was device friendly and can be filled up using computer, mobile phone or tablet. The survey period was 2 weeks and in total 497 emails were sent to the people from various walks of life which consist academicians, medical professionals, lawyers, media persons, public servants, students, social workers, traders and businessman etc. In total, 242 people tried to attempt the survey and 221 completed it, 21 questionnaires were partly filled which were not included in the result.

The questionnaire includes the questions ranging from demographic information of the respondent, and their familiarity with specific areas and sub-areas of Quetta city. Once the respondents consider any area familiar then a question about sub-areas appears to select familiar sub-areas. After the selection of sub-area(s), respondent had to mark sub-area(s) safe or unsafe and if not sure can select the choice “I don’t know”.

Following are the names of 11 major areas, the classification is based on the maps provided by Quetta Development Authority (QDA) and the common understanding of areas and their link with the major roads and highways in Quetta city.

i. Airport road & Baleli road
ii. Brewery road
iii. City Centre & surrounding areas
iv. Double road & Sirki road
v. Eastern Bypass
vi. New Hanna road
vii. Raisani road & Qambrani road
viii. Samungli road
ix. Sariab road
x. Spiny road & Joint road
xi. Western Bypass

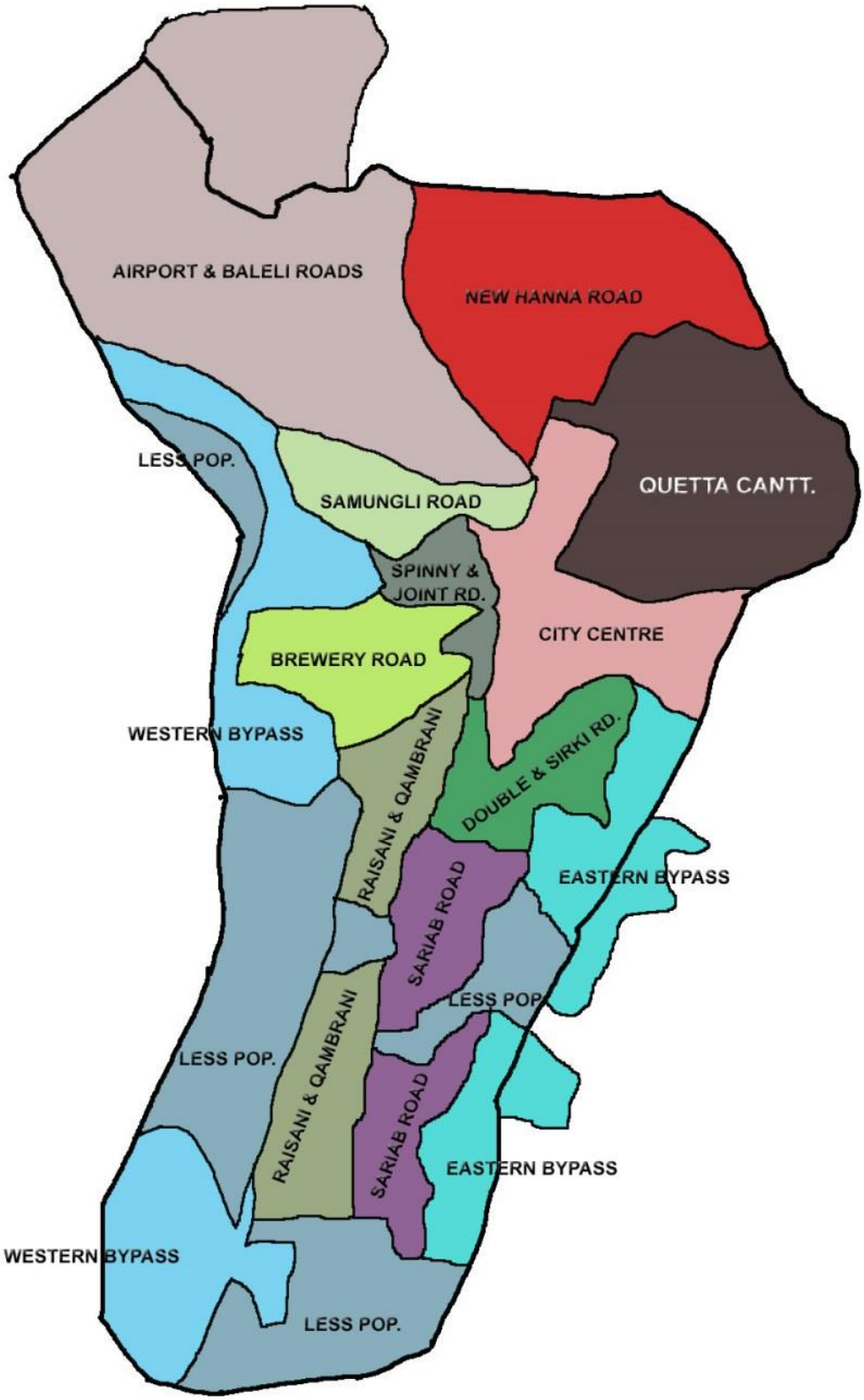

Figure 1 Areas of Quetta City

1.5 Results

The result of safety questionnaire is divided into demographic, familiarity, and safety, which are discussed further as following:

1.5.1 Age of respondents

The first question in the survey was about age of the respondent. Majority of the respondents were between the ages of 21y-30y (Figure 2) and no respondent was above 60y. It also reflects that internet is mostly popular among youngster than the old age people. According to (The Express Tribune, 2013) most of the internet users in the country are between the ages 18y-35y.

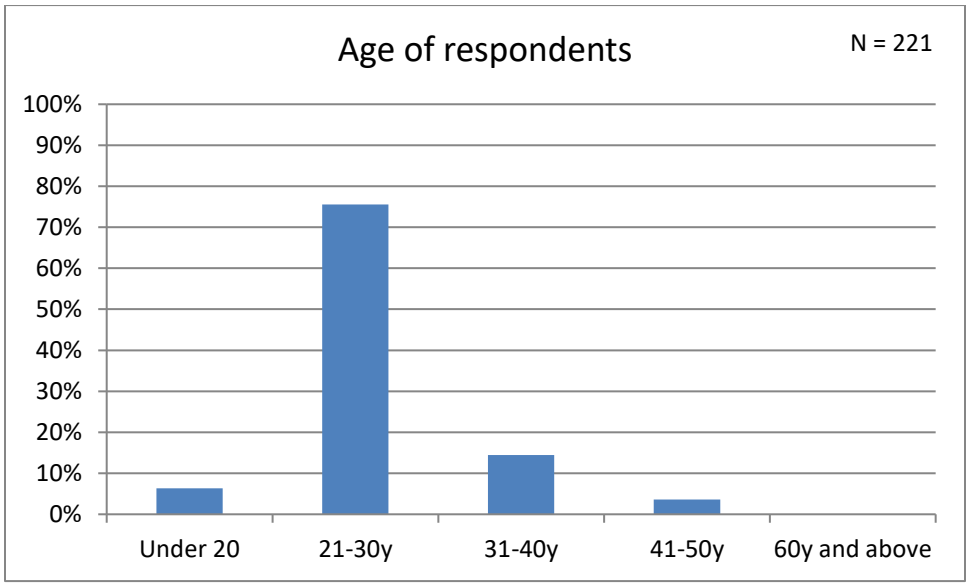

Figure 2 Age of respondents

1.5.2 Gender

Figure 3 shows that majority of respondents were male (82%) than female (18%). In Pakistan the percentage of literate male is higher than of female (World Bank, 2015) due to several reasons. Male internet users are higher (87%) than female (13%) as mentioned in (The Express Tribune, 2013).

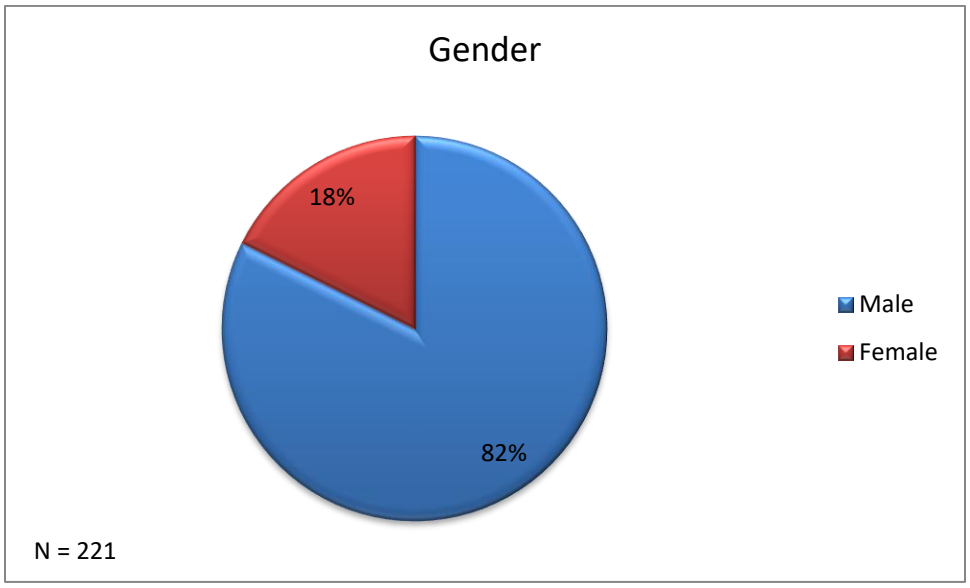

Figure 3 Gender of respondents

1.5.3 Mother tongue

In the sample of 221 responses, Pashto speaking were 40%, Urdu and Punjabi 12% while 11% people speak Balochi. 4% of the respondents speak other languages which are not local languages of Balochistan such as Gilgiti, Hindko, Shina (Figure 4).

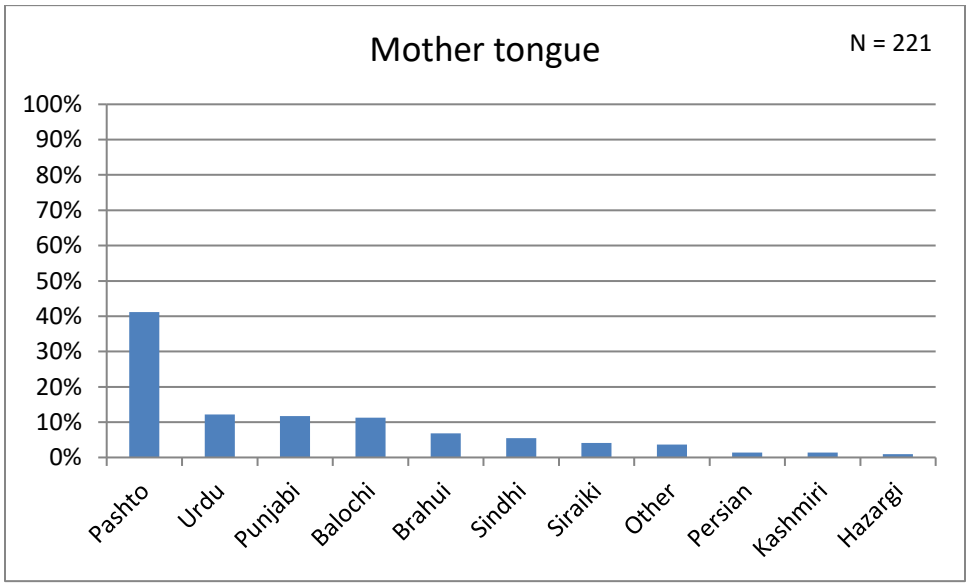

Figure 4 Mother tongue of respondents

1.5.4 Educational Qualification

Respondents also had to answer question regarding their educational qualification. It shows that majority of the respondents (Figure **5**) possess a bachelor qualification (60%), 24% of the respondents have master's degree while 3% selected 'other' as their educational qualification mentioning, technical education, PhD researcher etc.

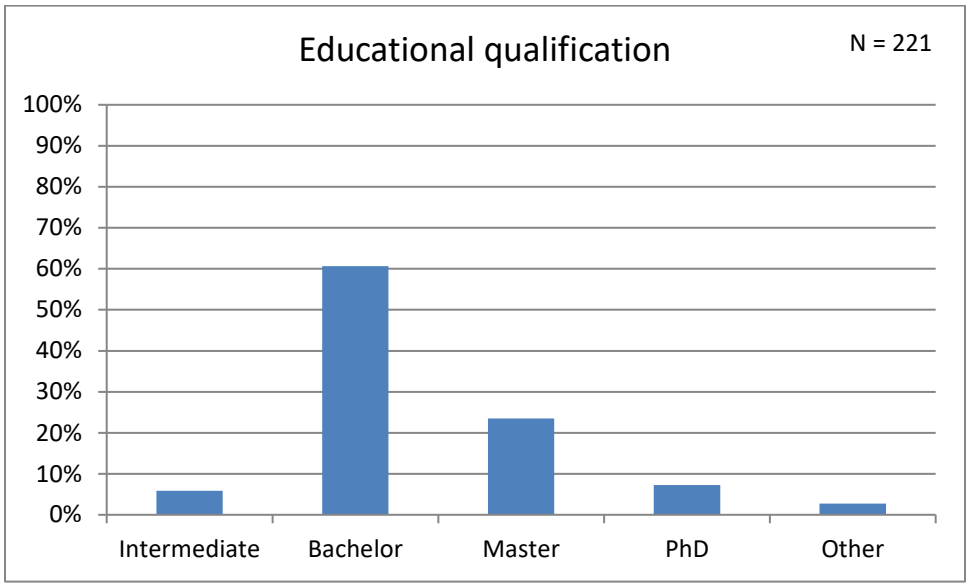

Figure 5 Educational qualifications of the respondents

1.5.5 Employment status

52% of the respondents out of 221 were employed which represents the majority while 35% were students. It also shows a trend of internet users in the city, since the survey was conducted online it can be said that people who are employed or who are students are more actively using internet.

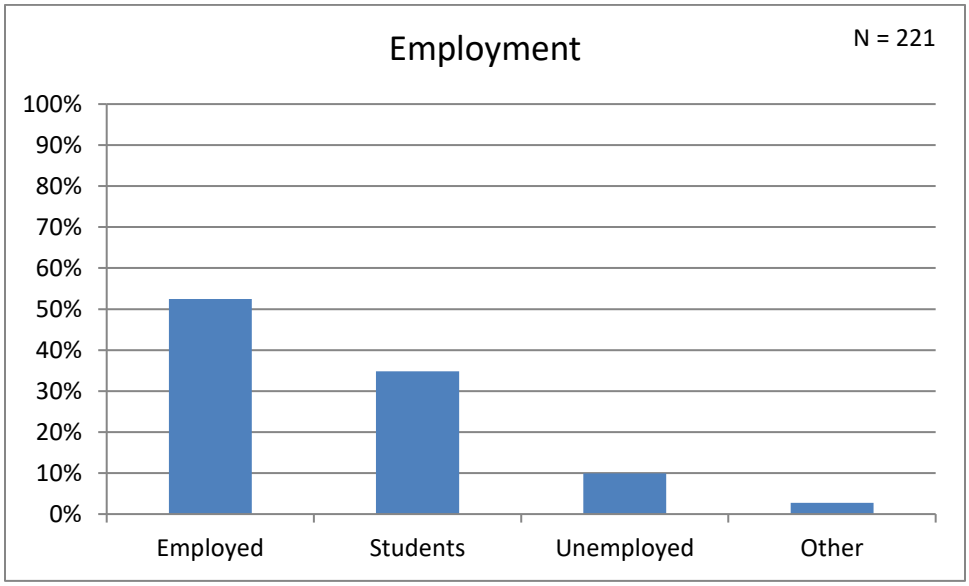

Figure 6 Employment status of respondents

1.6. Familiarity and Safety of areas

As mentioned earlier in Figure 1 Quetta city was divided into 11 major areas, in these question respondents have to mark the known or familiar areas. Familiarity varies from higher in North of Quetta and city centre to lower in South, East and West of Quetta city (Figure 7 and Figure 8). Airport and Baleli roads are in the north of Quetta city, Samungli is near city centre, Sariab road is in the South, Hanna road and Eastern Bypass in the East while Western Bypass is situated in the West of Quetta city.

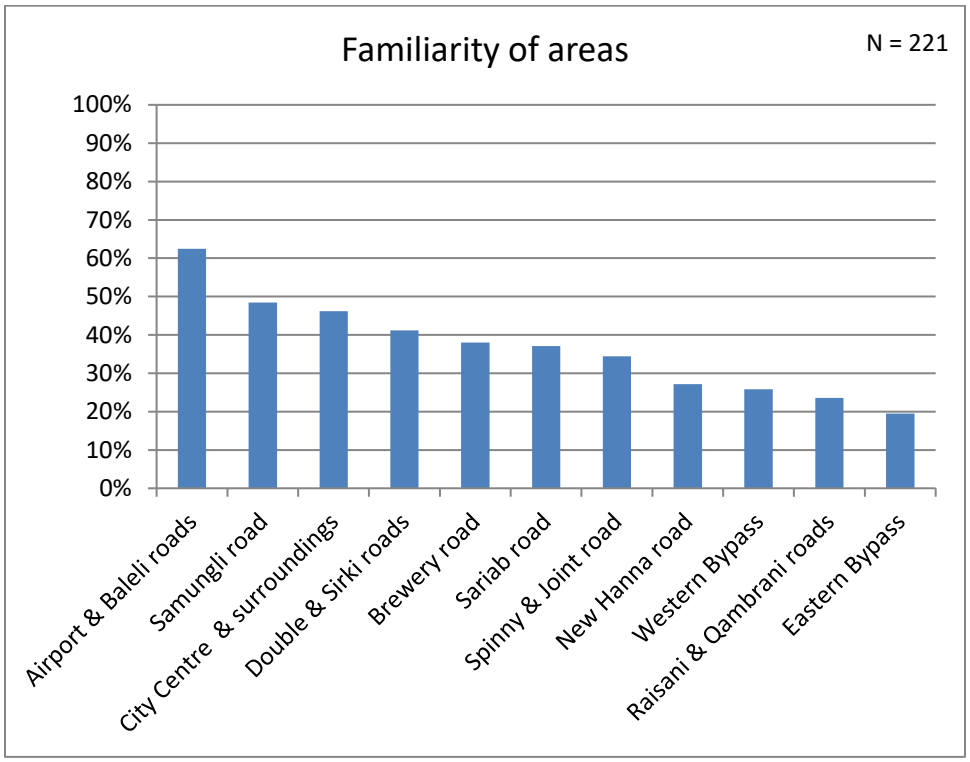

Figure 7 Familiarity of areas

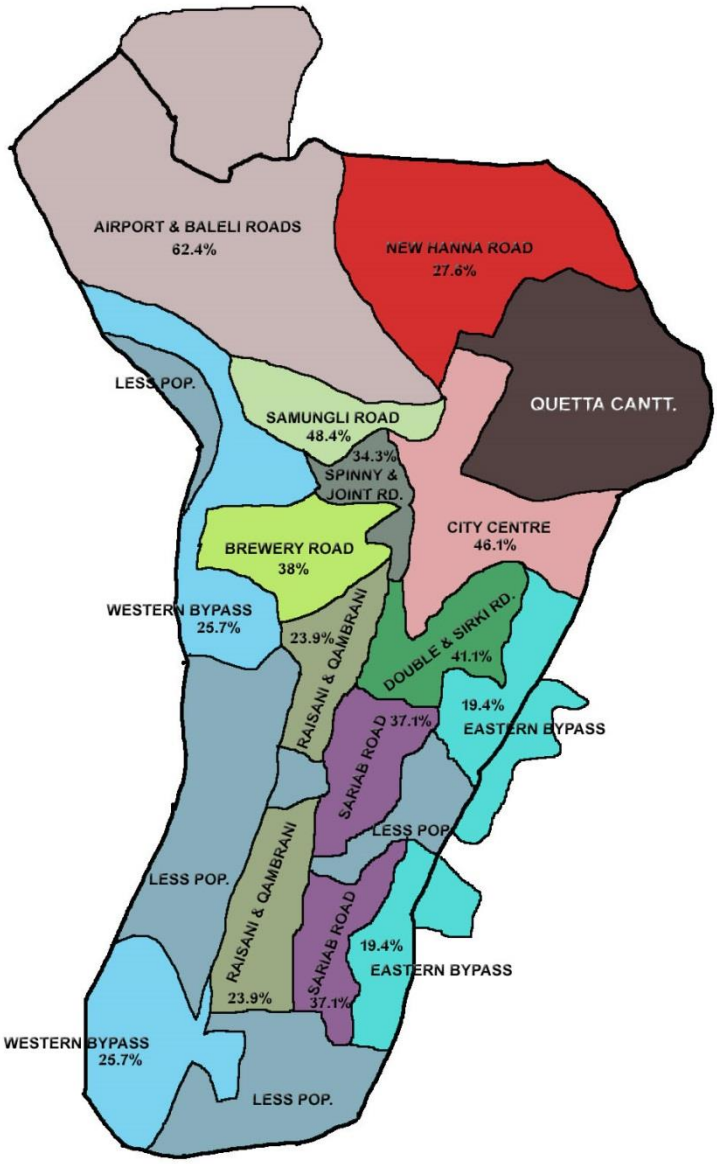

Figure 8 Familiarity of areas

1.6.1 Airport & Baleli roads

Airport & Baleli roads were more familiar or known area in Quetta as per the results of this survey. This area was further divided into 21 sub-areas, asking familiarity of sub-areas from the respondents who selected earlier that they are familiar with this area.

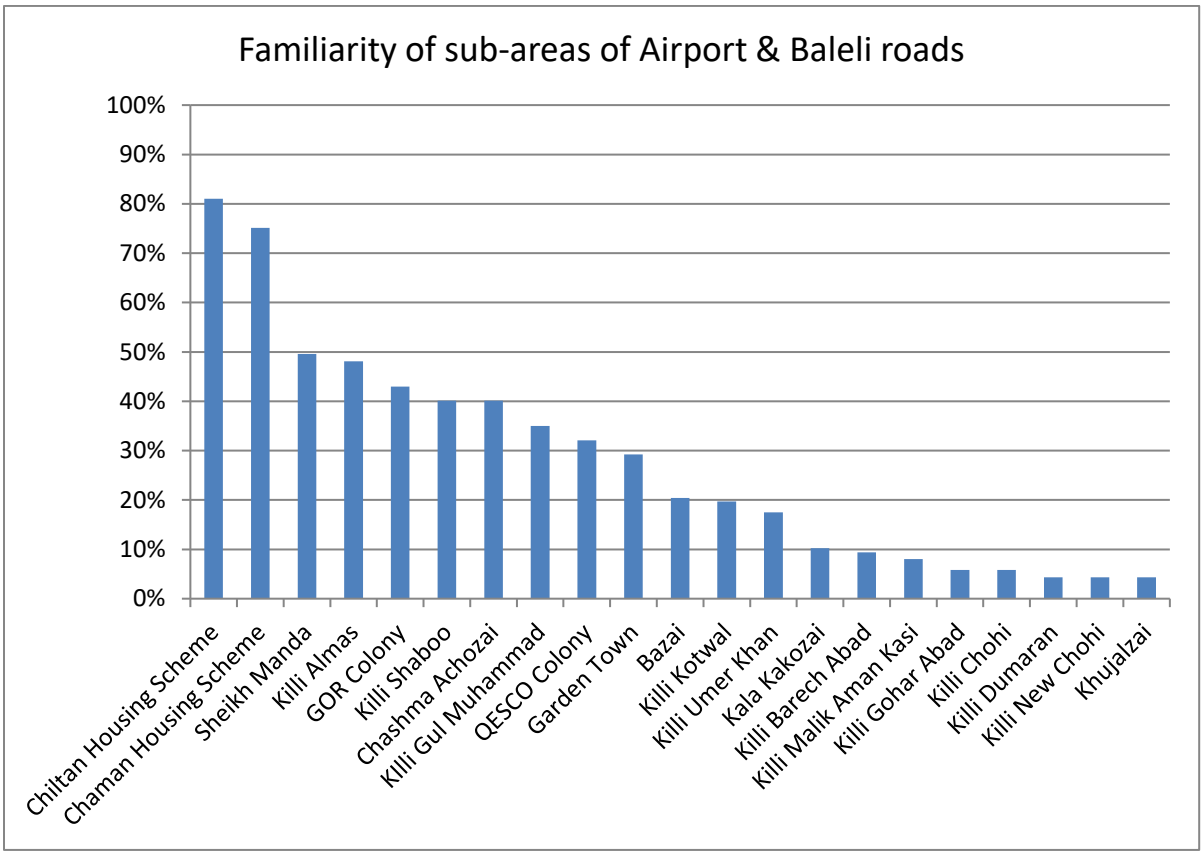

Figure 9 Familiarity of sub-areas of Airport & Baleli roads

Not all sub-areas with more familiarity score were considered safe for the housing survey (Figure 9 and Figure 10). Looking at the familiarity index the most famous areas are Chiltan housing and Chaman housing, both are also new residential developments at airport road. On the other side Sheikh Manda and Killi Almas are densely populated low-middle income areas and famous due to availability of cheap and affordable services like grocery stores, fresh vegetables, barber shops, dry cleaning, and laundry services etc.

In safety QESCO (Quetta Electric Supply Company) colony and GOR (Government officer's housing) colony stood 1st and 3rd and both are public housing areas. Chiltan Housing Scheme and Chaman Housing Scheme stood 2nd and 4th. The no. of respondents who live/ lived or visited these 4 sub-areas is represented in Figure 11.

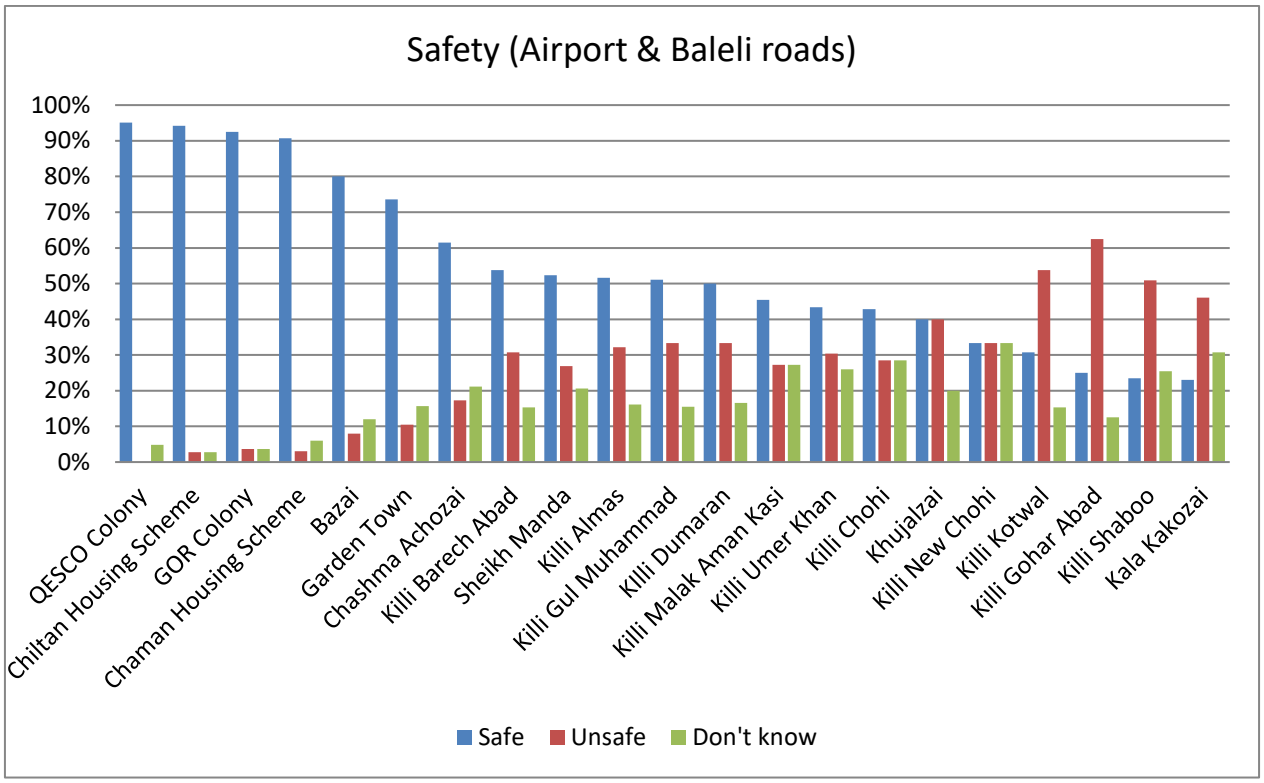

Figure 10 Safety of sub-areas (Airport & Baleli roads)

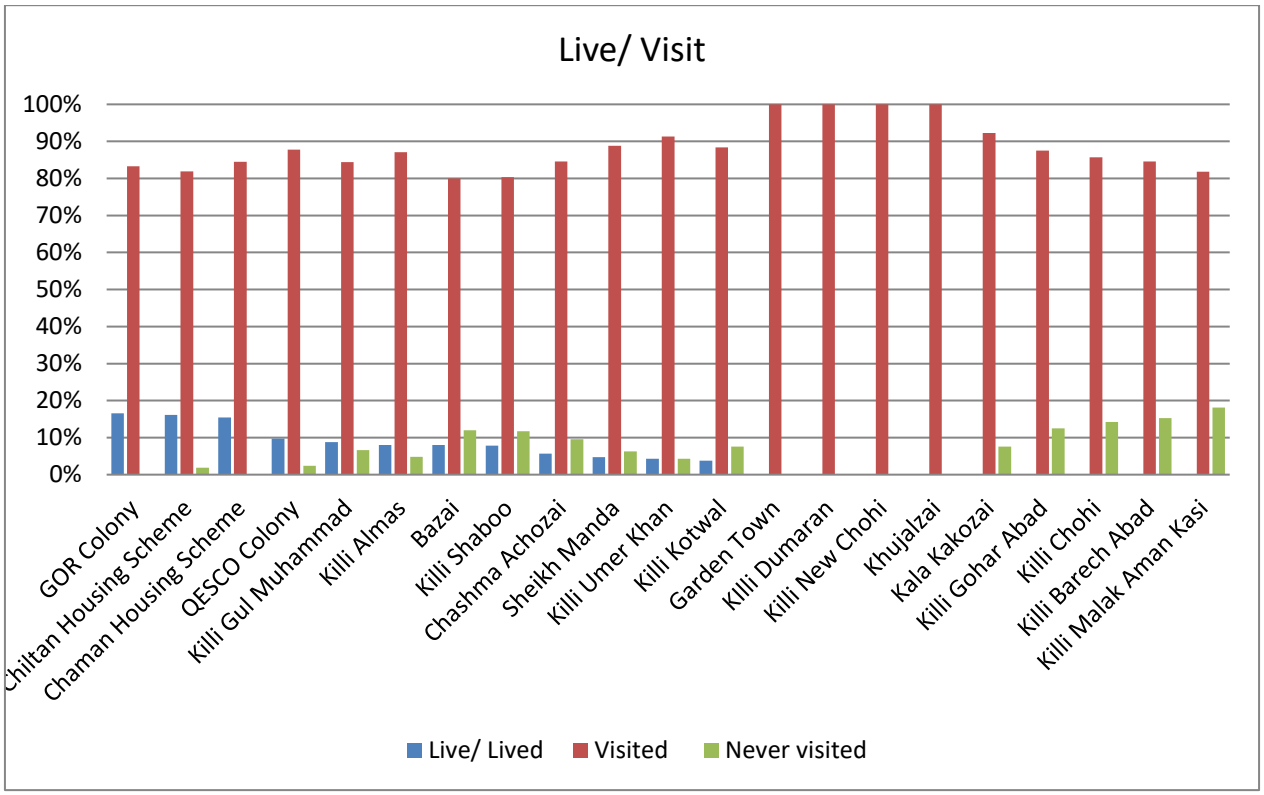

Figure 11 Live/ Visit (Airport & Baleli roads)

1.6.2 Samungli road

Samungli road was the second most known area marked in this survey. The road is also famous due to its busy food street and residential areas. It leads to Pakistan Airforce Base Samungli Quetta and it is linked with Airport road, city, and Western Bypass.

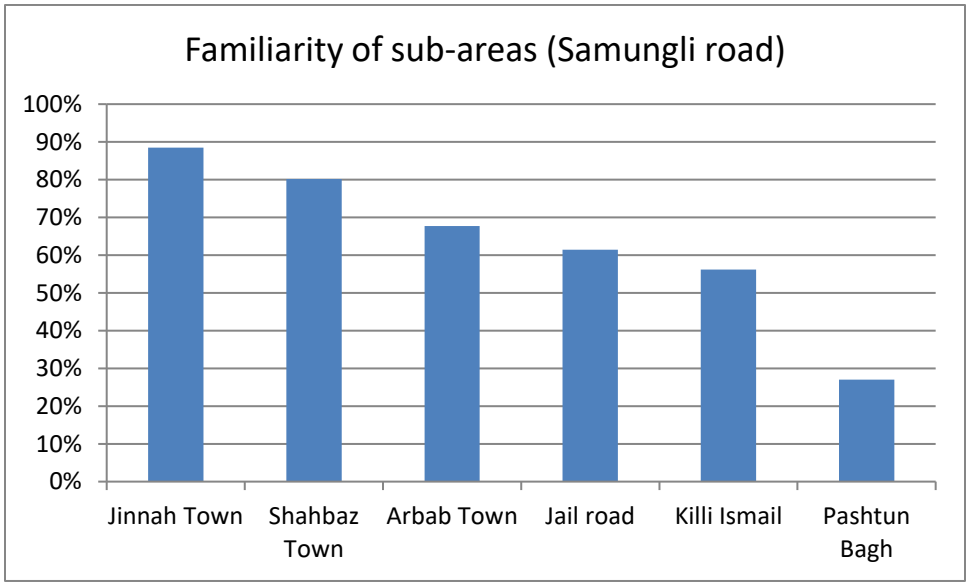

Figure 12 Familiarity of sub-areas of Samungli road

According to the survey results, Jinnah Town and Shahbaz Town (Figure 12) were most famous areas located at Samungli road and both are planned housing developments. Considering the results of safety Arbab Town, Jinnah Town and Shahbaz Town were marked safe (Figure 13) by majority of respondents which includes residents and visitors. Arbab Town also have considerable Christian population and people falling under with middle-low income groups.

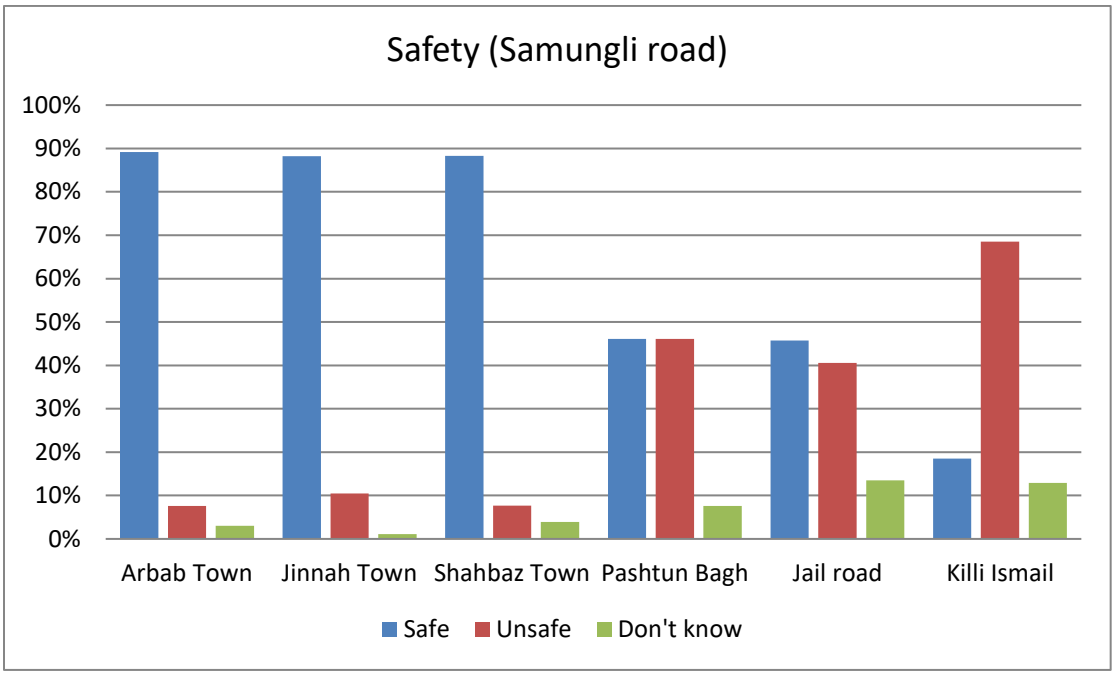

Figure 13 Safety of sub-areas (Samungli road)

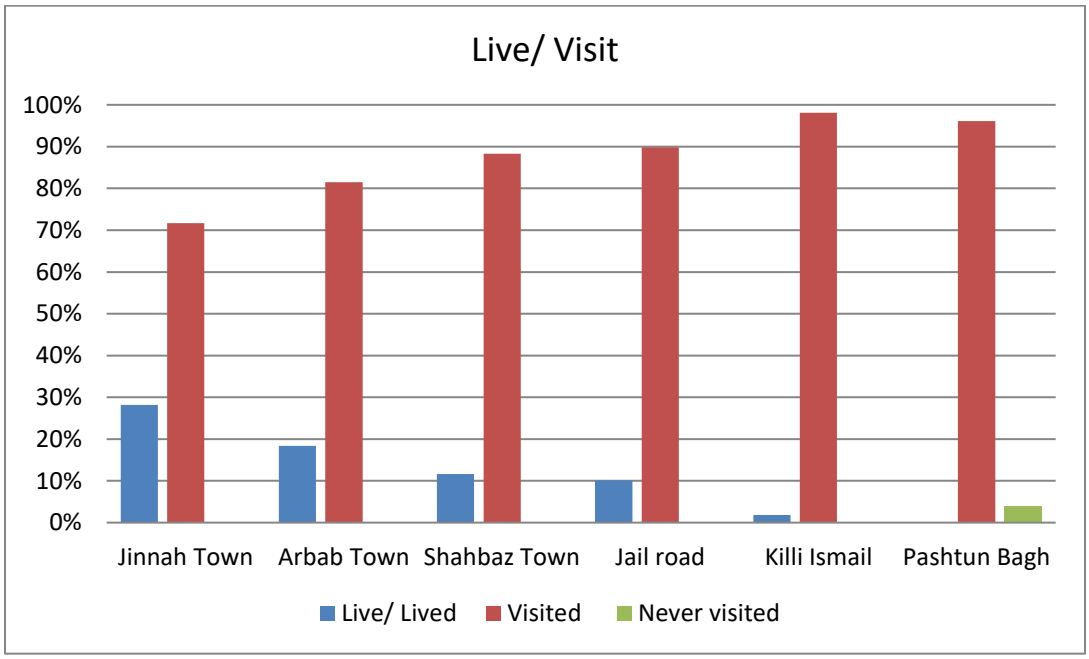

Figure 14 Live/ Visit (Samungli road)

1.6.3 City centre & surrounding areas

The residential areas located in Quetta city and surroundings were considered more famous and known to many people. Most of these areas are commercial or mixed use, i.e. commercial and residential while public buildings and offices are also located in surrounding localities. M.A (Mohammad Ali) Jinnah road shortly pronounced as Jinnah road was marked more familiar/ know area (Figure **15**). The road connect city with Quetta Cantonment, Zarghoon road and other major routes. All the banks and financial institutes have their branches located in the periphery of Jinnah road and one entrance of Civil Hospital Quetta is also located there. Mostly it is commercial area with plenty of shops and markets. Similarly, Liaquat Bazar is the main family market (Bazar) of Quetta and Masjid road, Fatima Jinnah road, Prince road are all mainly commercial areas.

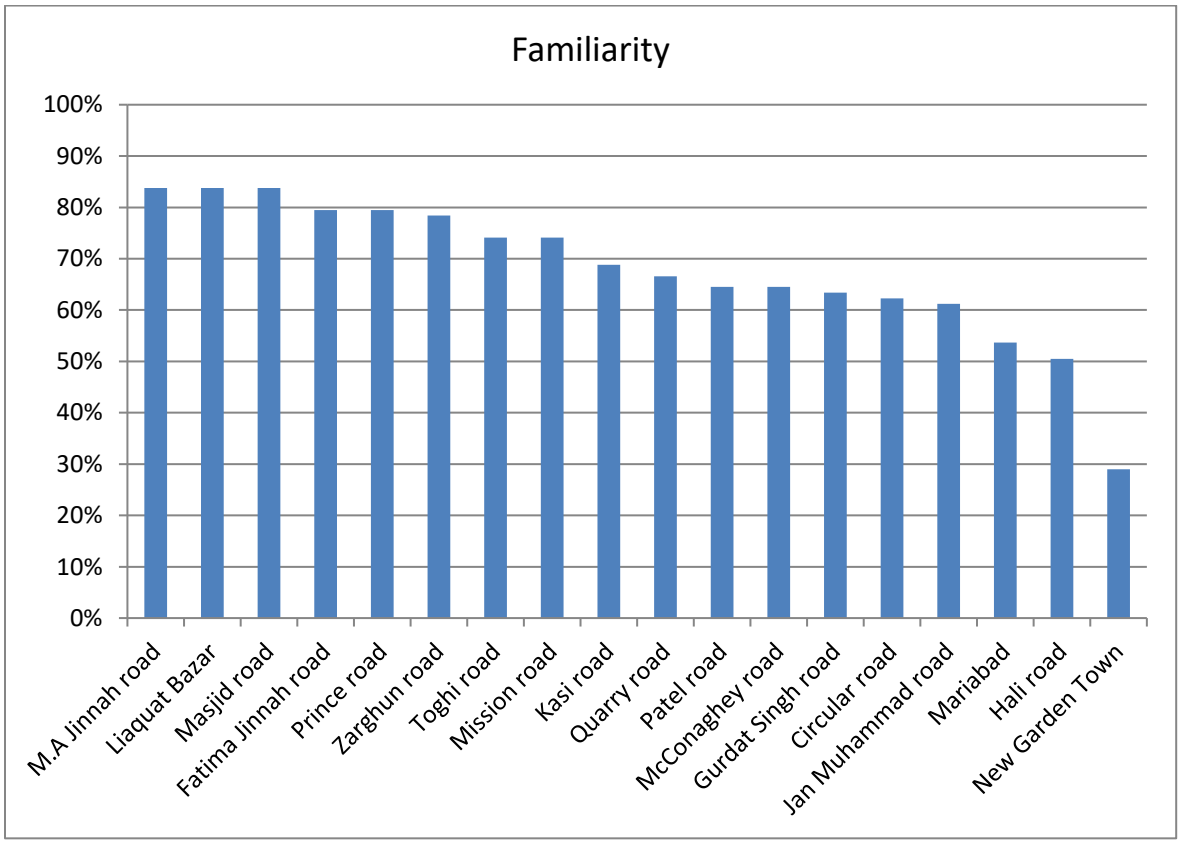

Figure 15 Familiarity of sub-areas (City centre and surroundings)

M.A Jinnah road is also marked most safe area following Hali road (Figure 16). Considering the respondents who live in these areas, Mariabad was first with 12% of residents and 86% of the visitors (Figure 17). But Mariabad was marked unsafe to go and visit for all people. Mariabad is one of the residential area of Hazara Community, since last few year people from this community are being targeted and killed due to sectarian problems in the city. Since then people other than the residents of Mariabad cannot visit or enter to this area without any invitation or without proving their complete identity and purpose of visit. There are few housing schemes and residential colonies located in Mariabad.

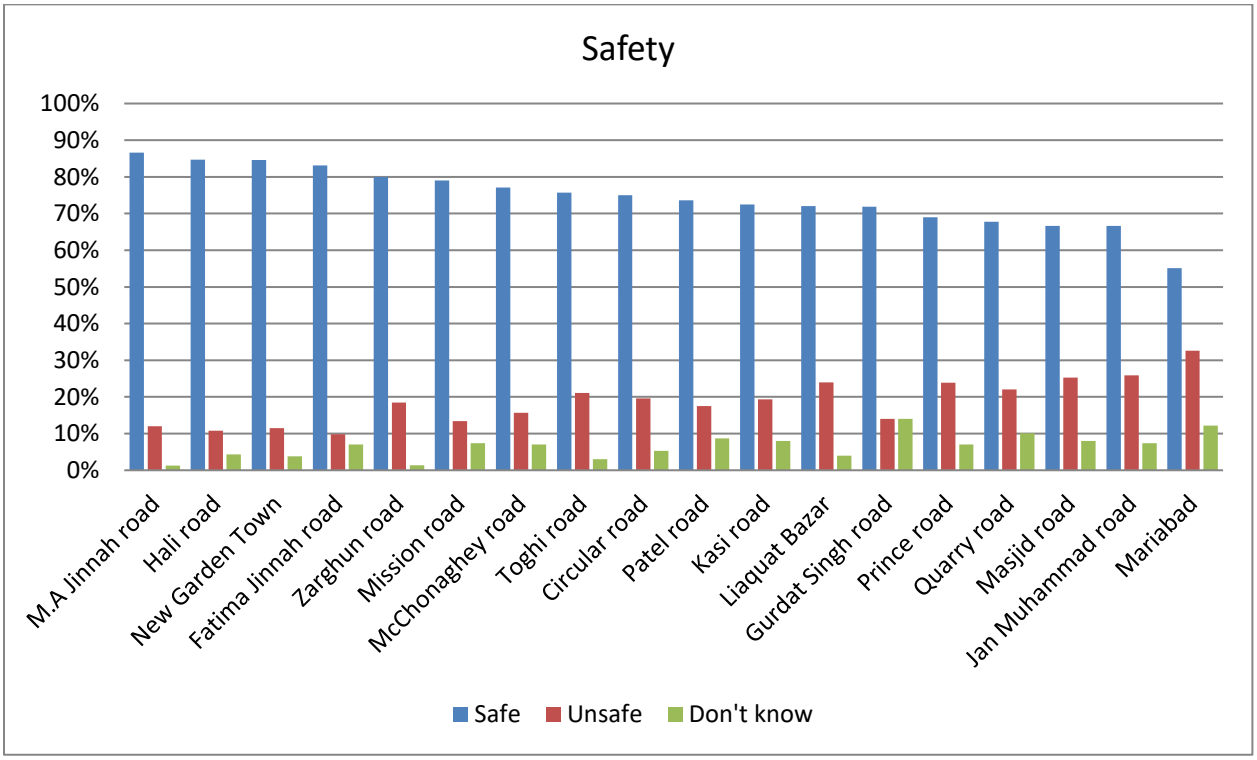

Figure 16 Safety of sub-areas (City centre and surroundings)

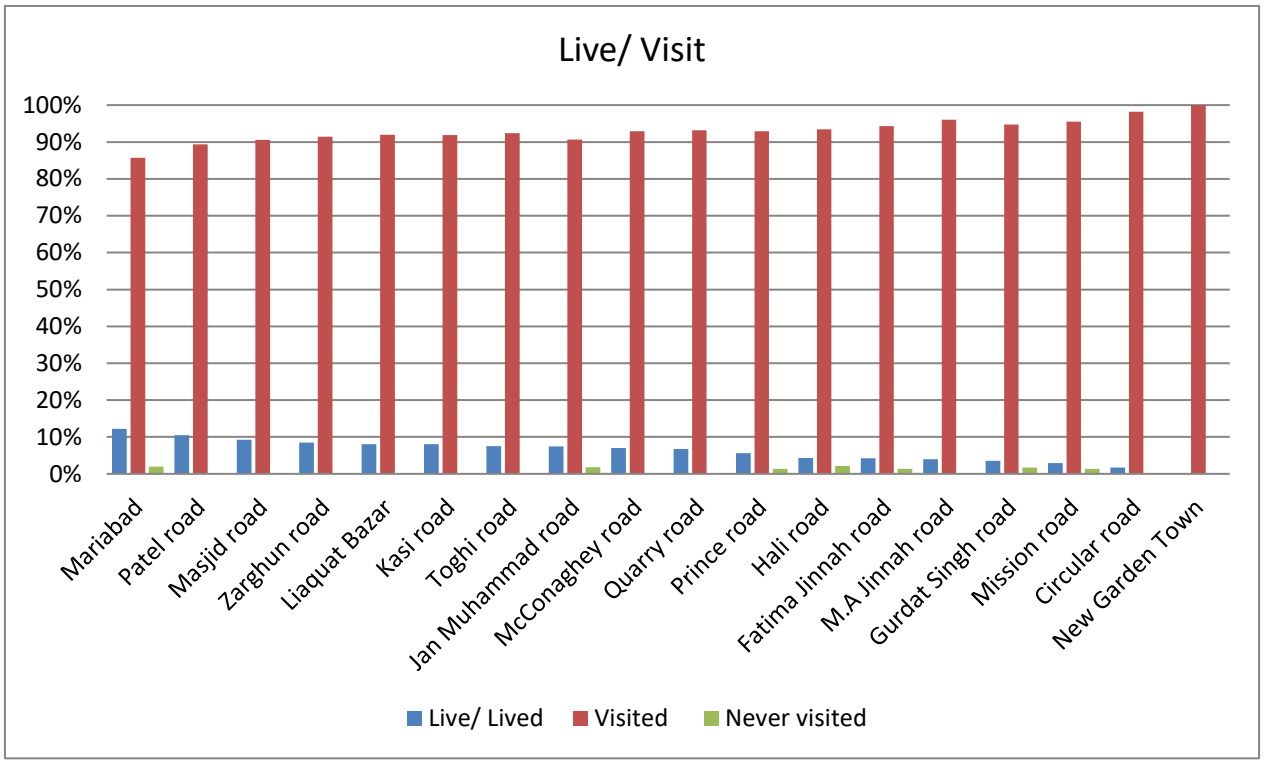

Figure 17 Live/ Visit (City centre and surroundings)

1.6.4 Double and Sirki roads

Double road and Sirki road area is close to Quetta city centre. Double road is famous for commercial activities including Russian market (where one can buy smuggled items), car showrooms and auto service shops. Satellite town was marked the most famous residential area (Figure 18); it is also the oldest planned development of Quetta which is divided in 5 blocks. During Soviet-Afghan War (1979-1989), Taliban regime (1996-2001) and US War in Afghanistan (2001-2014) many people from Afghanistan moved to Satellite town creating uneven development which leads to haphazard situation. Double road area (including satellite town) also got affected by terrorist activities several times in past few years.

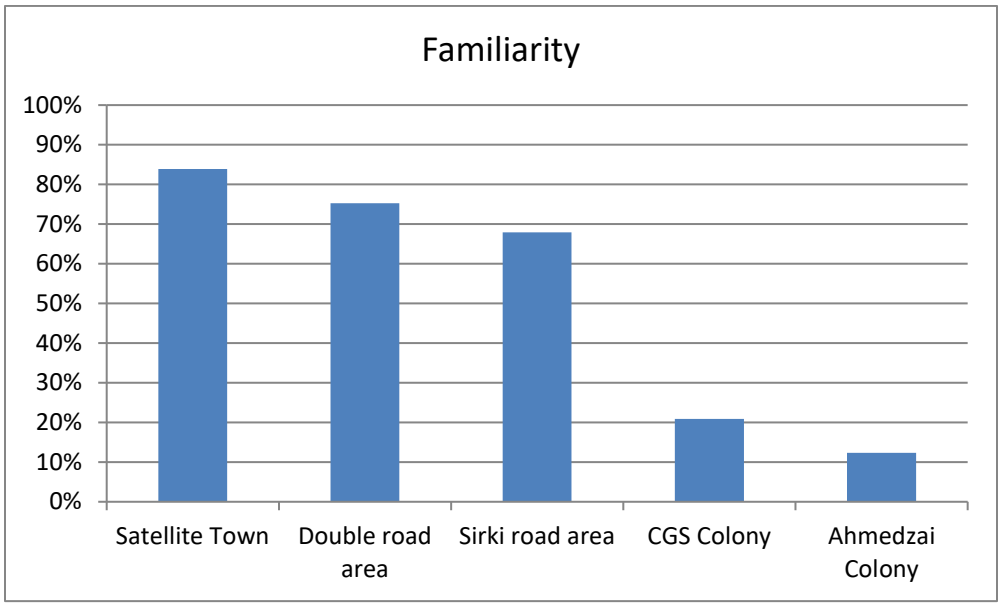

Figure 18 Familiarity of sub-areas (Double and Sirki roads)

CGS Colony is public housing area and it is considered safer than rest of the housing areas located I the peripheries of Double or Sirki roads (Figure 19). Most of respondents live or visited these areas marked Double road and CGS colony, 1st and 2nd respectively (Figure **20**).

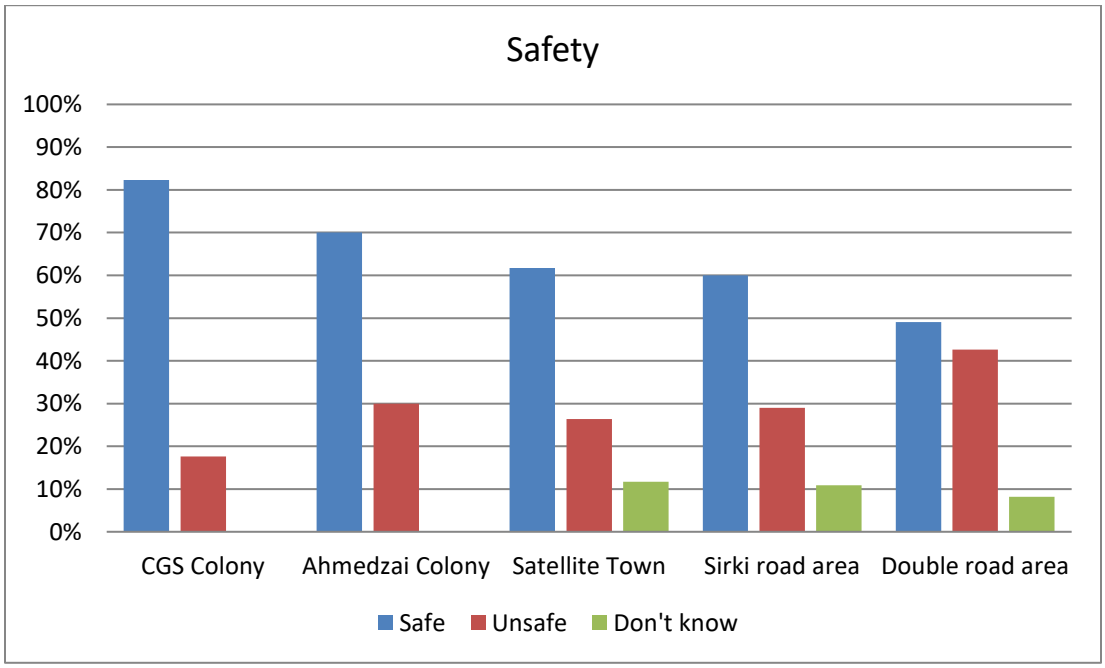

Figure 19 Safety of sub-areas (Double and Sirki roads)

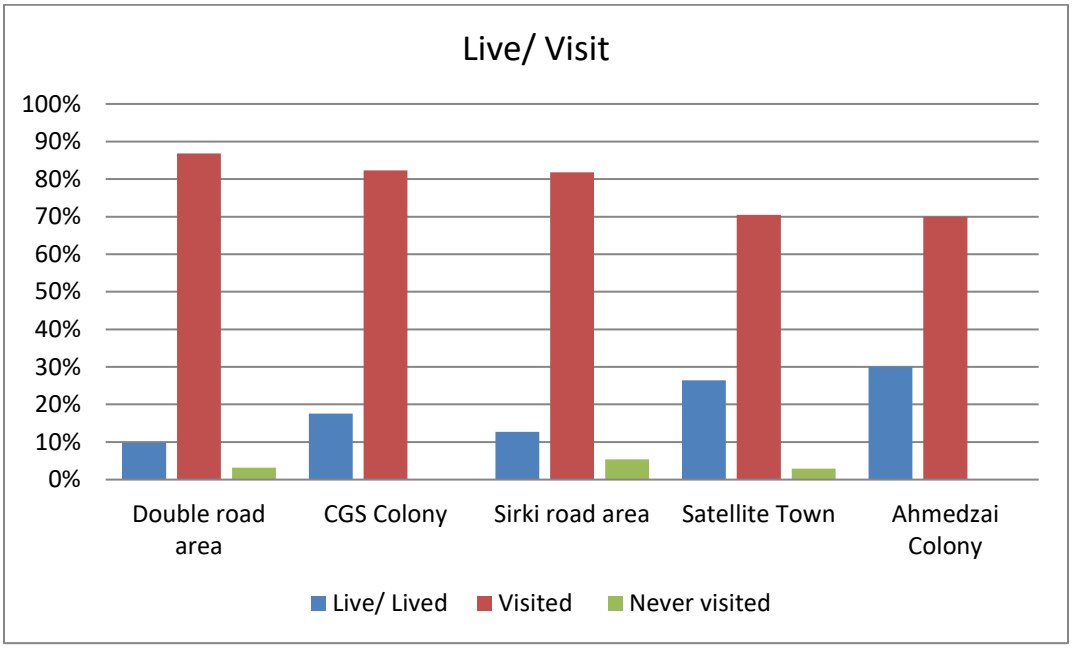

Figure 20 Live/ Visit (Double and Sirki roads)

1.6.5 Brewery road

Brewery road is famous due to location of Balochistan Medical College (BMC) and Sardar Bahadur Khan (SBK) Women University. Railway Housing Society, Wahdat Colony and Faisal Town were marked top 3 known residential areas located at Brewery road (Figure 21) while College road, Railway Housing Society and Durrani Town were marked top 3 safe areas marked by the respondents (Figure **22**).

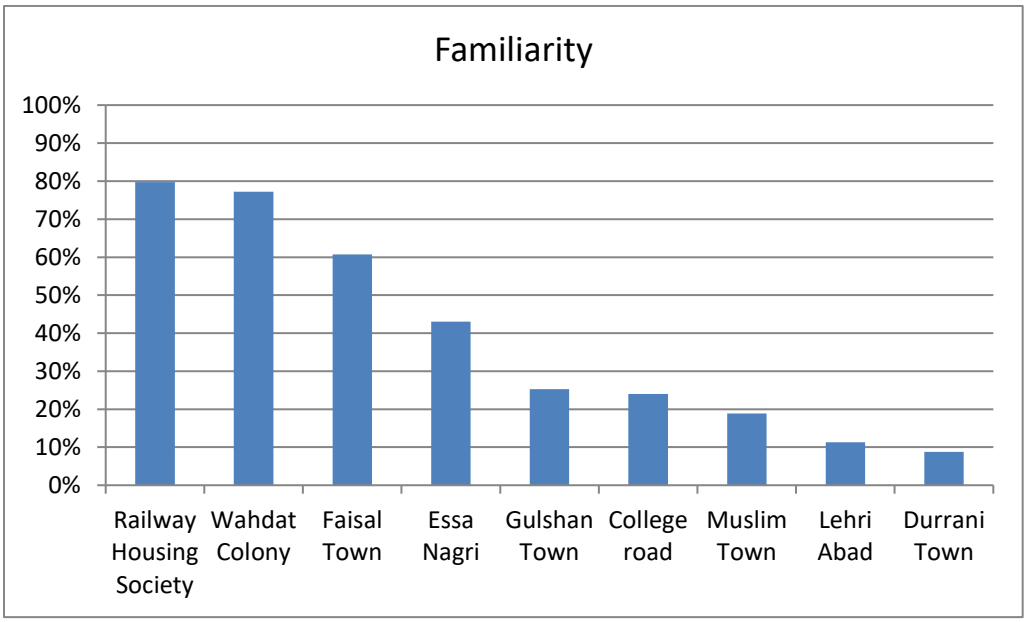

Figure 21 Familiarity of sub-areas (Brewery road)

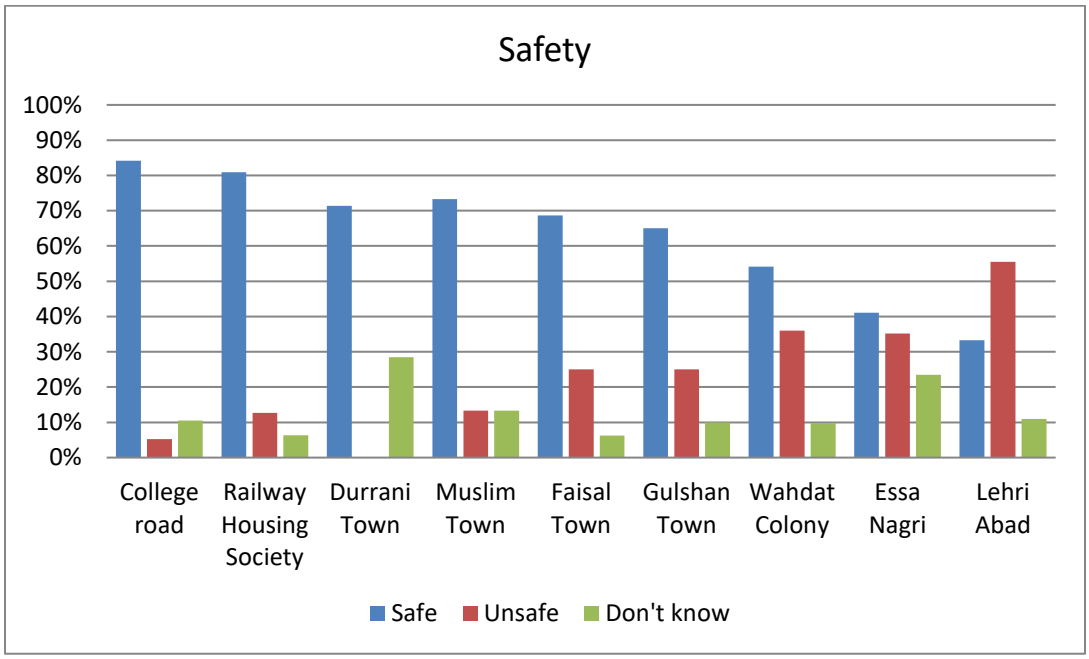

Figure 22 Safety of sub-areas (Brewery road)

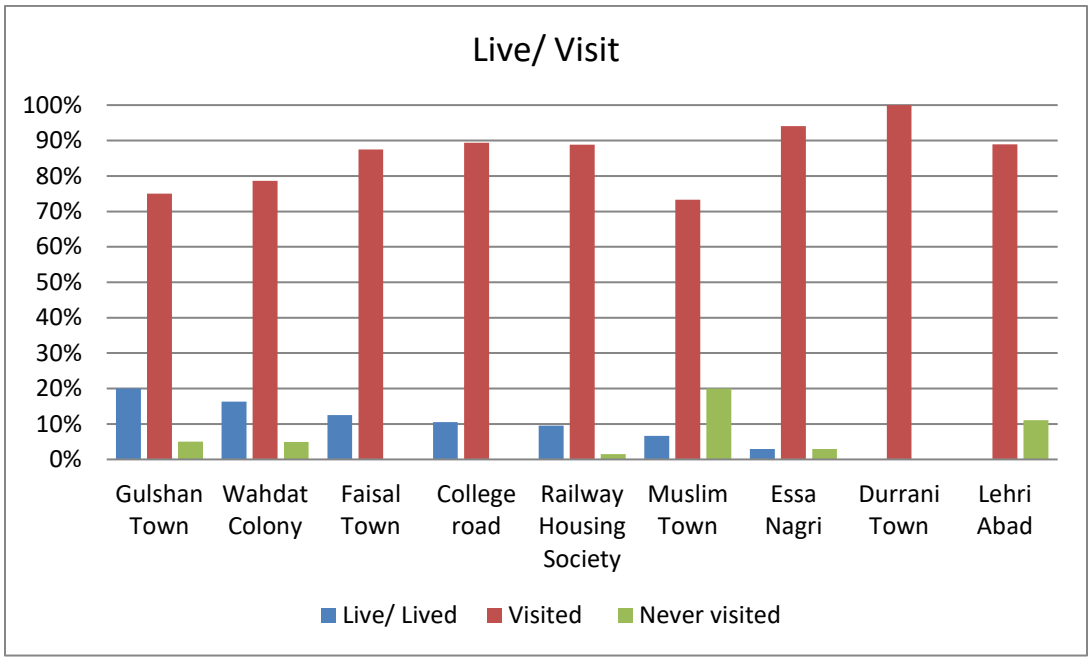

Figure 23 Live/ Visit (Brewery road)

1.6.6 Sariab road

Sariab road is one of the longest roads in Quetta. It is also very important road since it connects the city with the route to 2 major cities of Sindh province, i.e. Sukkur and Karachi. Sariab road is also transport hub of Quetta, inter-city buses and bus companies mainly operate from Sariab road. A huge population of Baloch tribes live in the vicinity of Sariab road and University of Balochistan (UoB) is also located there. The area remained disturbed since 2006 after the death of Nawab Akbar Bugti in a military operation. Nawab Bugti was the Chief tribal lord of all the Baloch tribes in Balochistan. Sariab road and its nearby areas became the hub of Baloch Liberation Army (BLA) and other separatist groups. Many suicide bomb attacks, killings and terrorist activities occurred in Sariab road area in recent years. Beside that oldest Baloch neighbourhood such as Shahwani, Kechi Baig are located at Sariab road. Sariab Mill colony, Kechi Baig and Grid Station Colony (Figure **24**) were marked top 3 known areas as per the survey. The residential areas located at Sariab road were mostly marked unsafe by many respondents (Figure **25**).

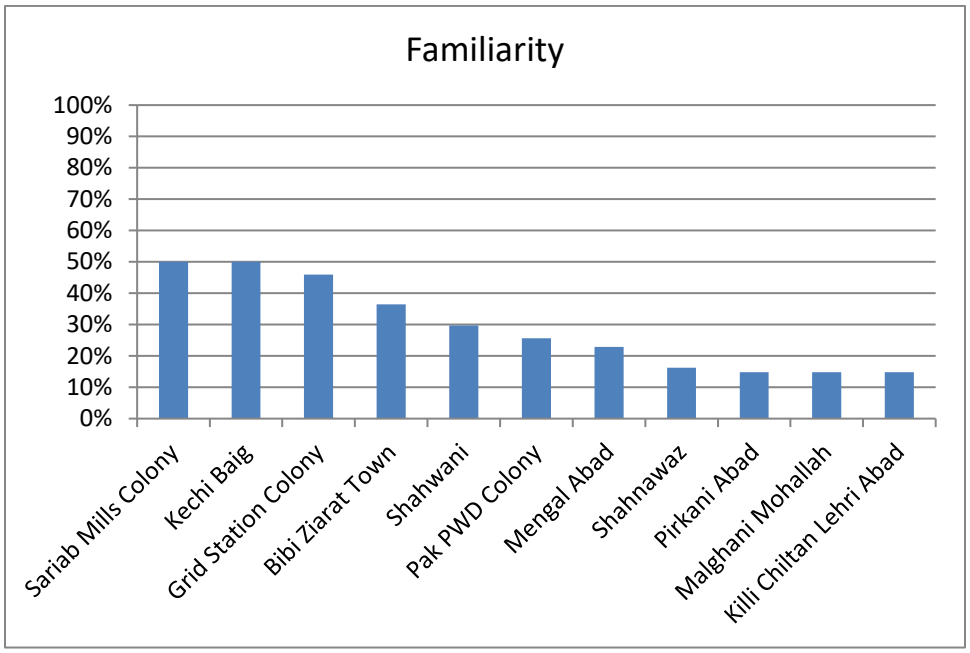

Figure 24 Familiarity of sub-areas (Sariab road)

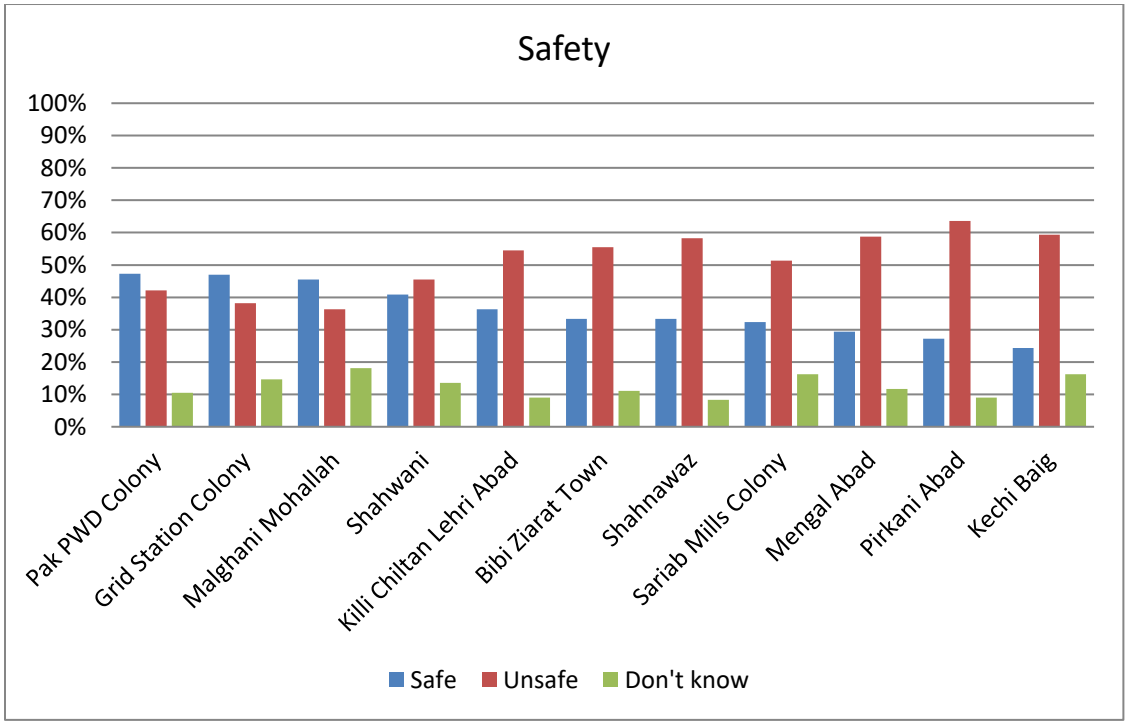

Figure 25 Safety of sub-areas (Sariab road)

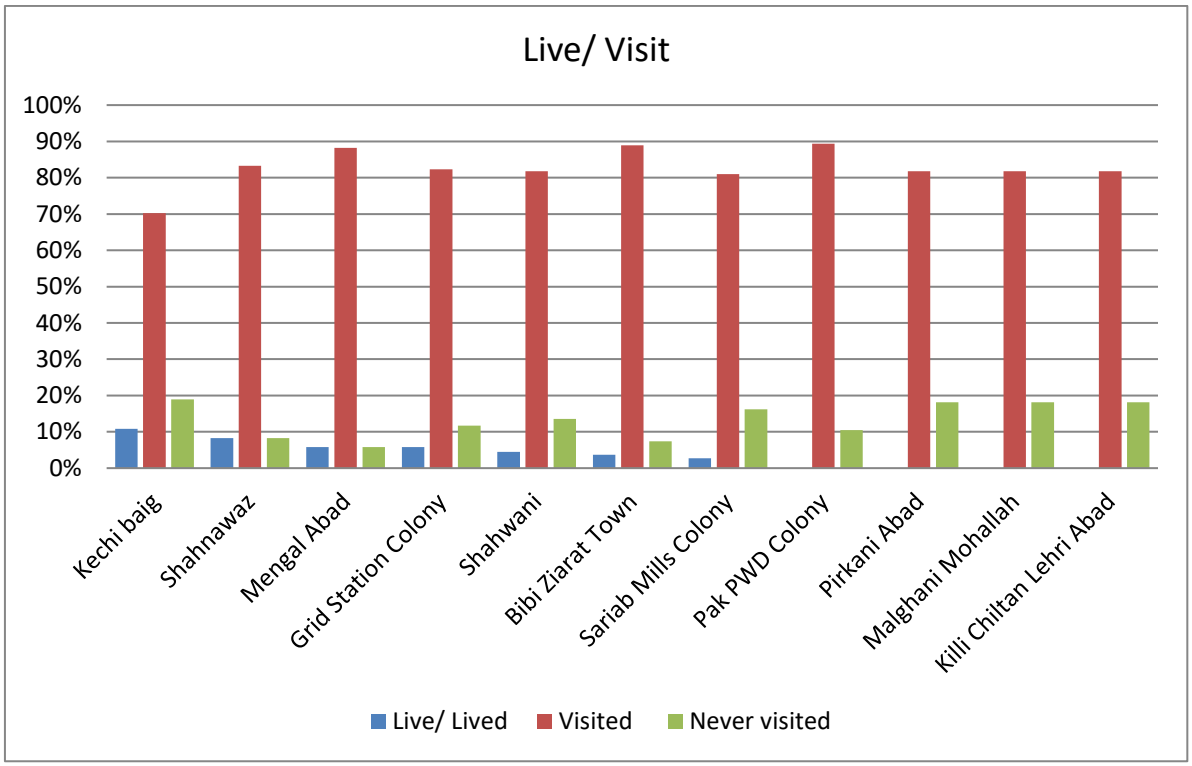

Figure 26 Live/ Visit (Sariab road)

1.6.7 Spiny & Joint roads

Railway colony, Joint road and Killi Huda were marked the most familiar sub-areas located at Spiny and Joint roads area. The Railway colony mostly consist Staff Bungalows and residential quarters for the employees of Pakistan Railways. Killi Huda, Killi Deba and Tarkha Kasi are old neighbourhoods. Railway colony was marked the safest sub-area following Faqirabad and Joint road (Figure 28).

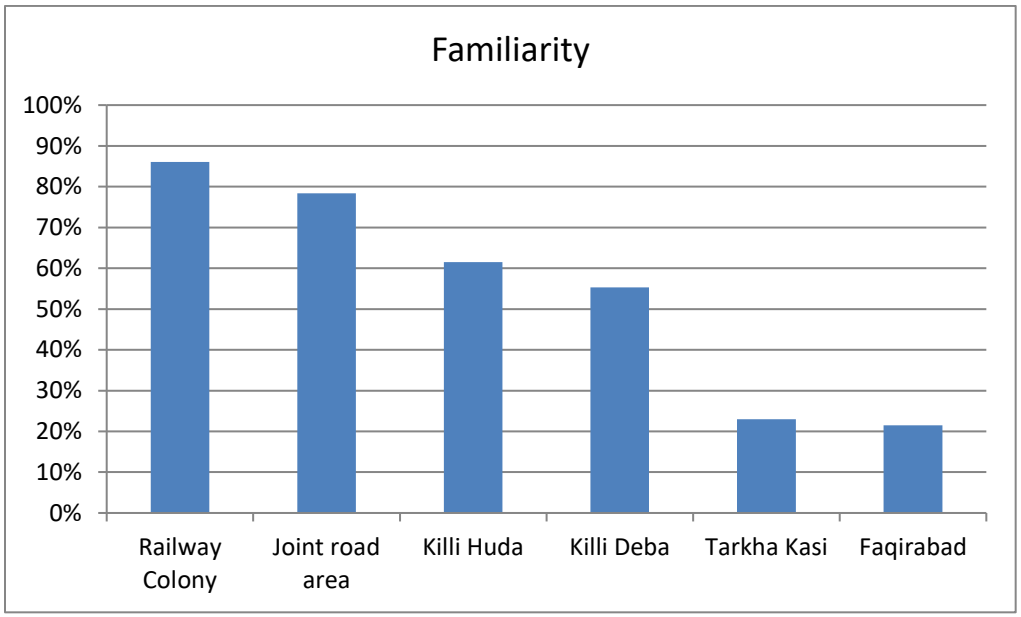

Figure 27 Familiarity of sub-areas (Spiny & Joint roads)

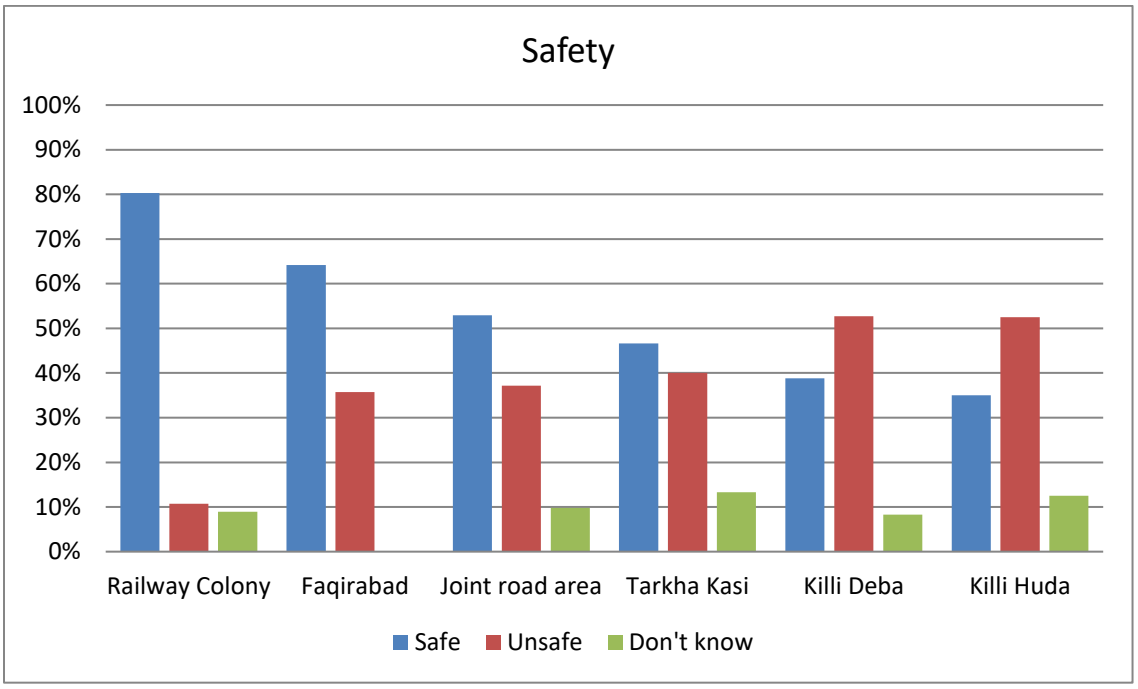

Figure 28 Safety of sub-areas (Spiny & Joint roads)

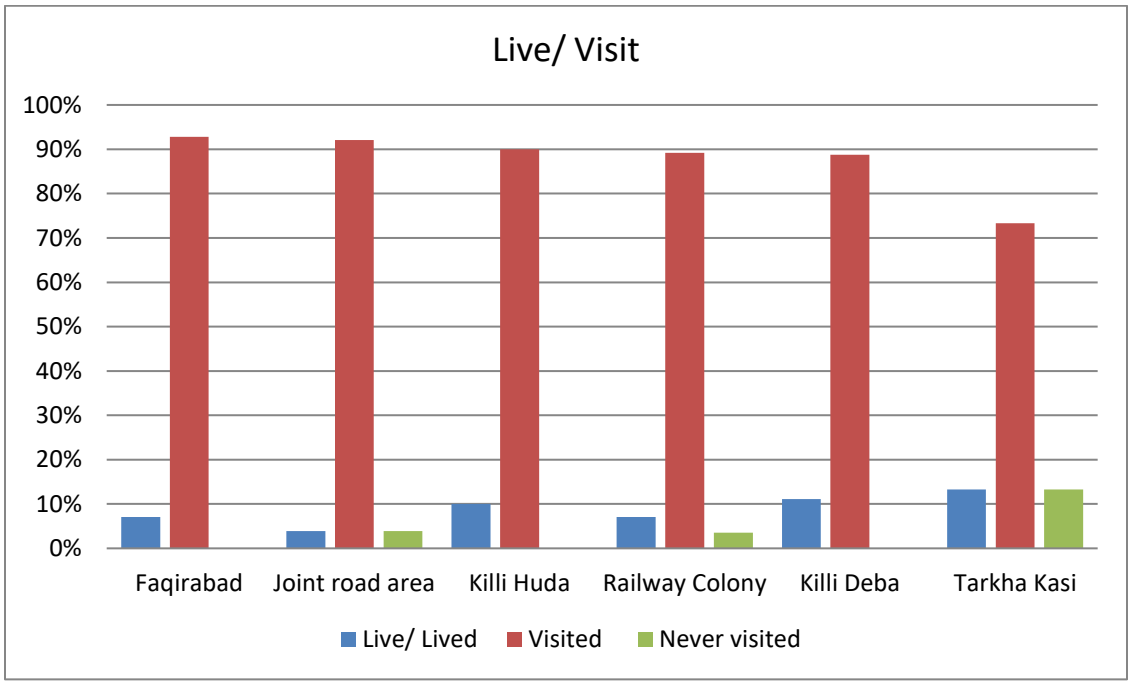

Figure 29 Live/ Visit (Spiny & Joint roads)

1.6.8 New Hanna road

The housing areas on New Hanna road are mainly developed in last 20-25 years. In the beginning it got famous for low-medium income communities and later planned housing areas also came into existence. Nawai Killi is the oldest and most famous residential area (Figure 30) located at New Hanna road while Kashmir Colony is marked most safe area (Figure 31).

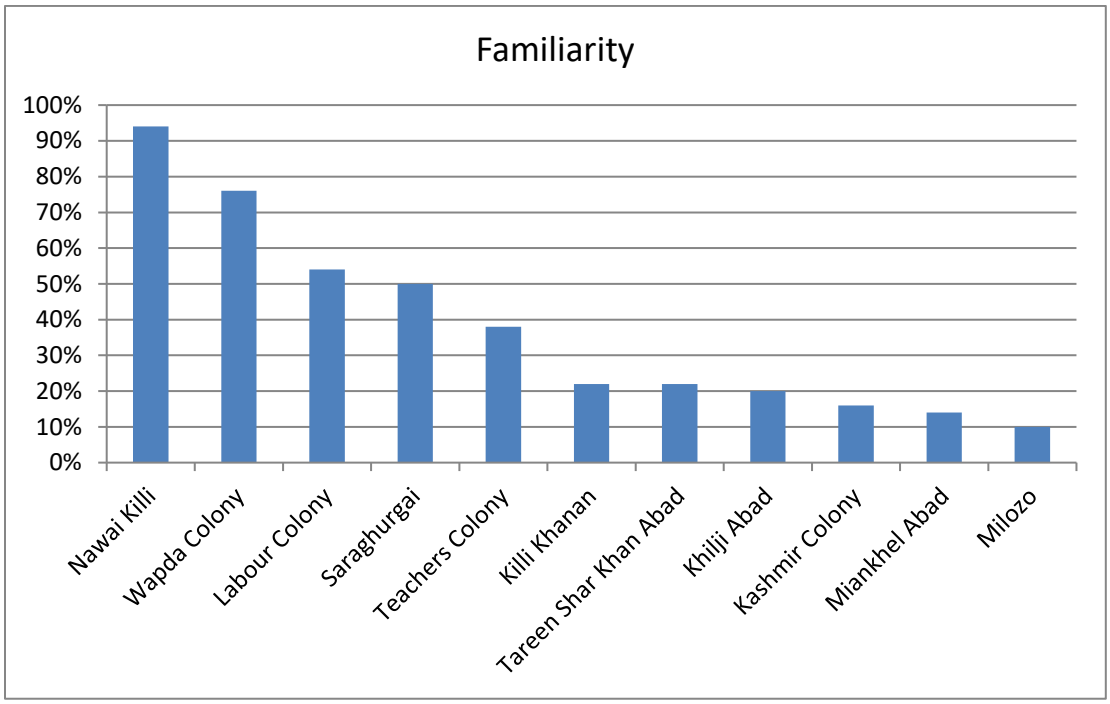

Figure 30 Familiarity of sub-areas (New Hanna road)

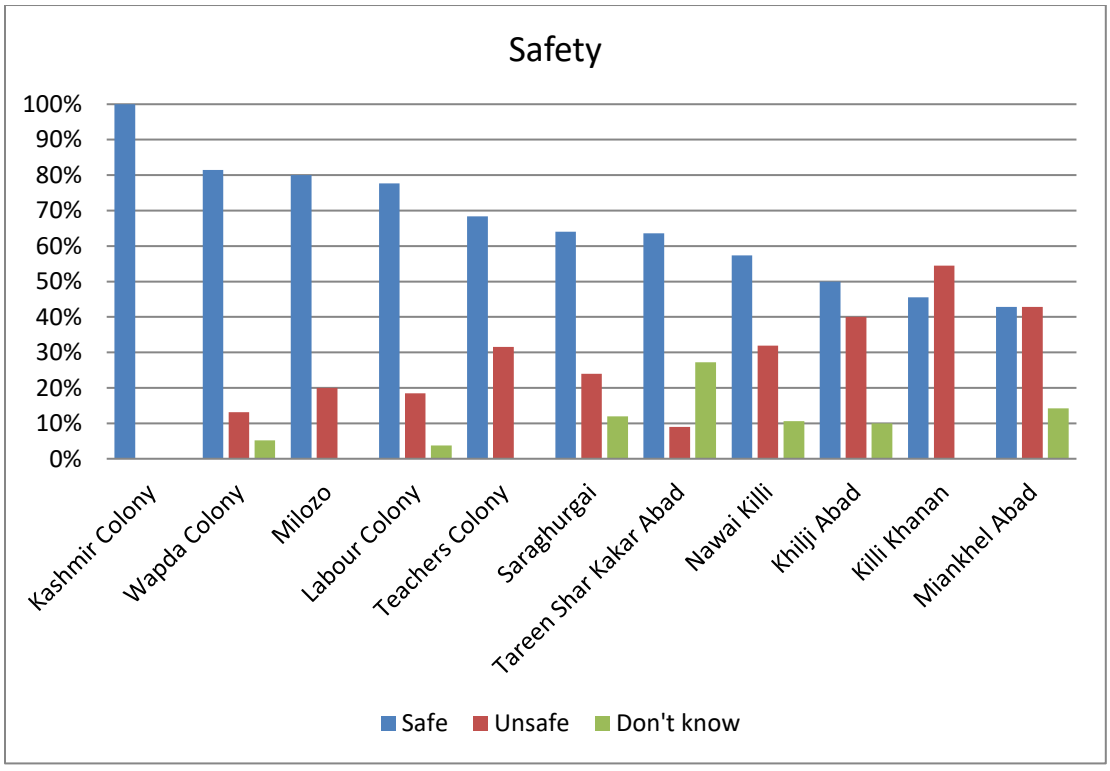

Figure 31 Safety of sub-areas (New Hanna road)

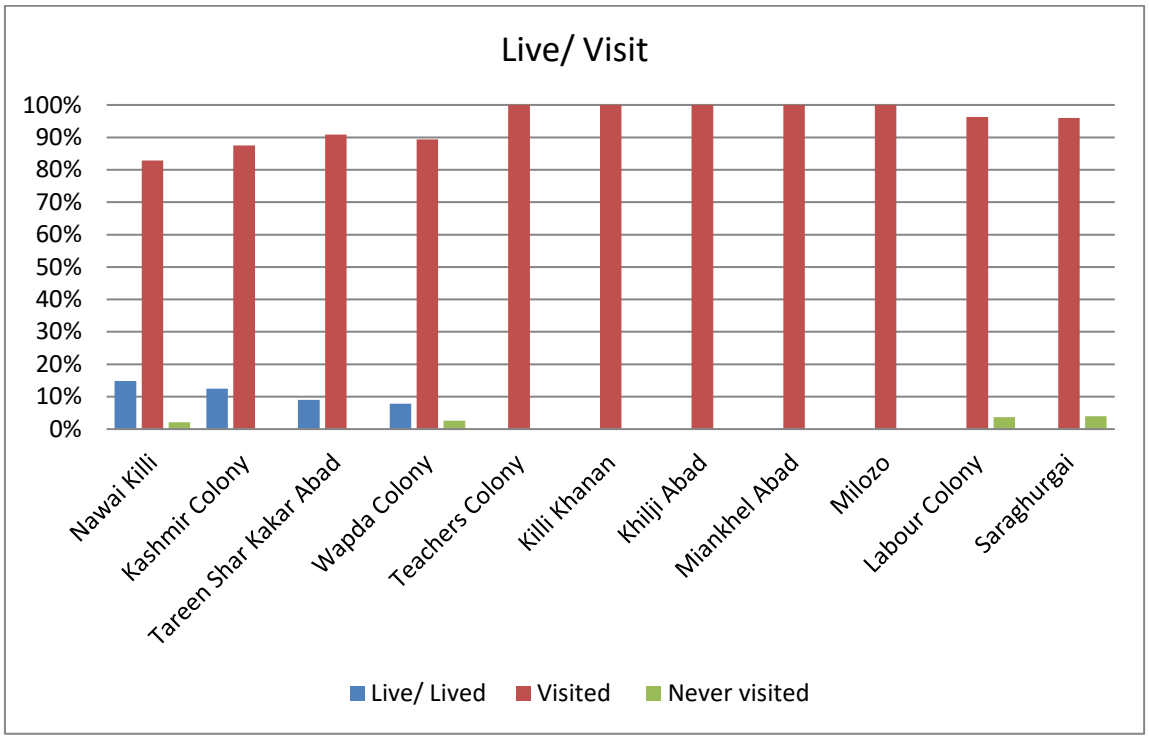

Figure 32 Live/ Visit (New Hanna road)

1.6.9 Western Bypass

Western Bypass is a highway connecting major areas of Quetta and giving traffic free access to international route which connect Afghanistan and Pakistan. Kharot Abad, Hazara Town and Hazarganji areas are well-known (Figure 33). Kharot Abad is the largest slum of Quetta while people of Hazara community live in Hazara Town and Hazarganji is the main transport hub for Iran and proposed bus terminal of Quetta city will also be constructed at Hazarganji. Main Fruit and vegetable market (Sabzi Mandi) of Quetta is also located in Hazarganji.

Most of the areas located at Western Bypass were marked unsafe by a good number of respondents except (Figure **34**) Emaan Housing Society and Gohar Abad sub-areas which were marked safe.

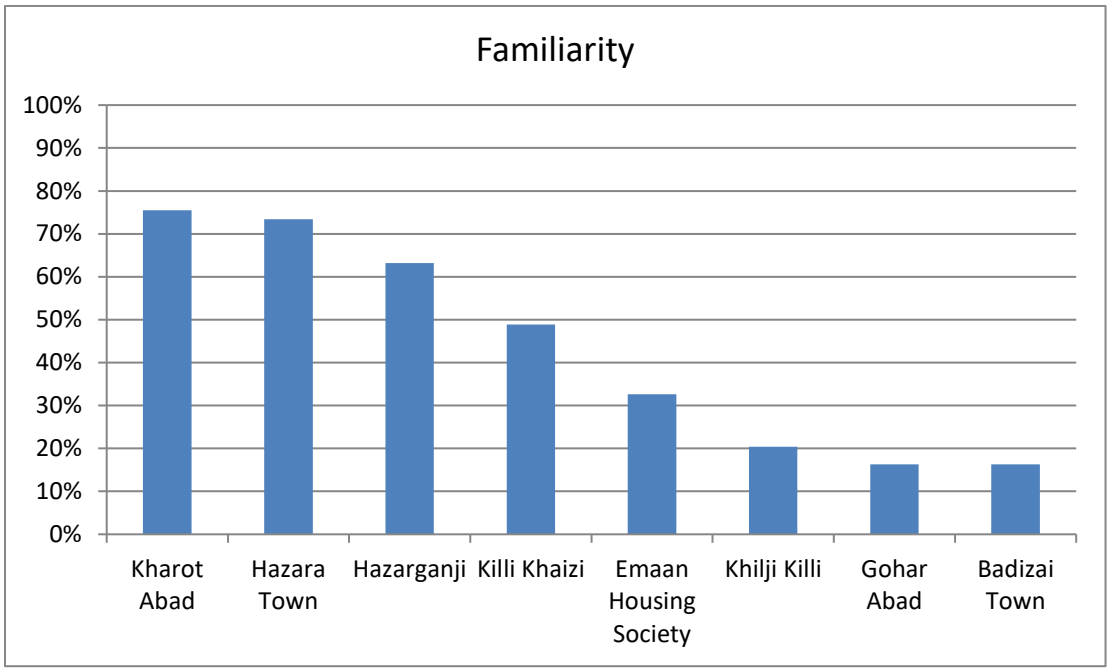

Figure 33 Familiarity of sub-areas (Western Bypass)

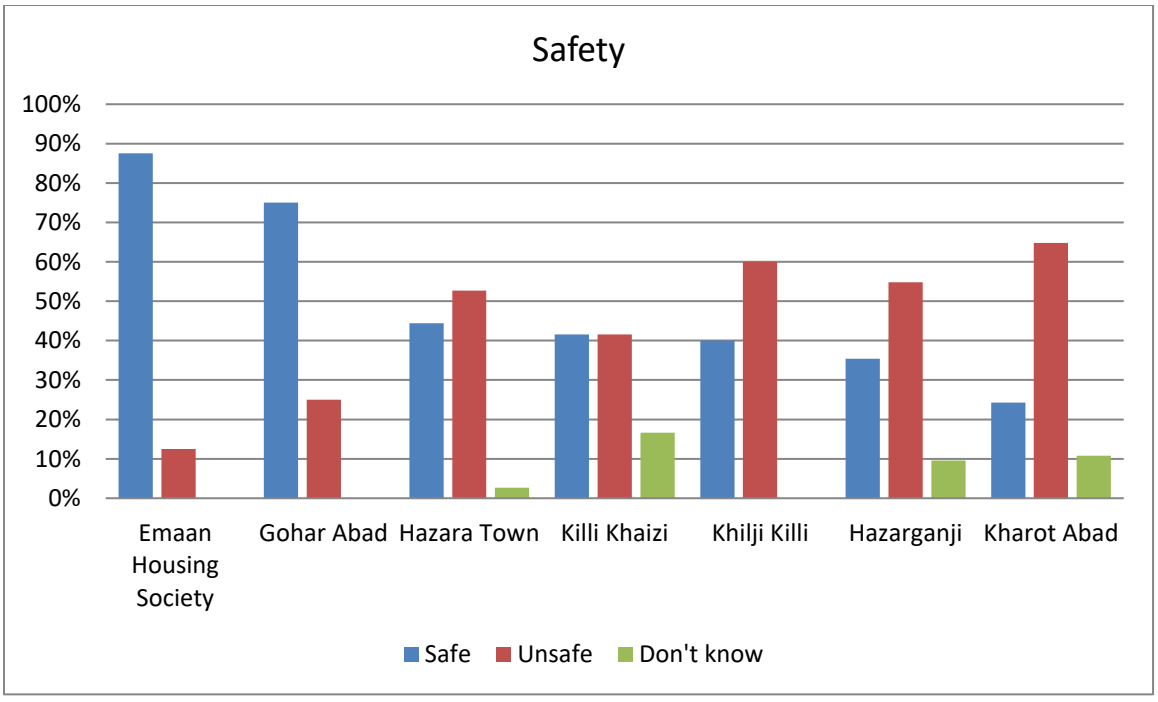

Figure 34 Safety of sub-areas (Western Bypass)

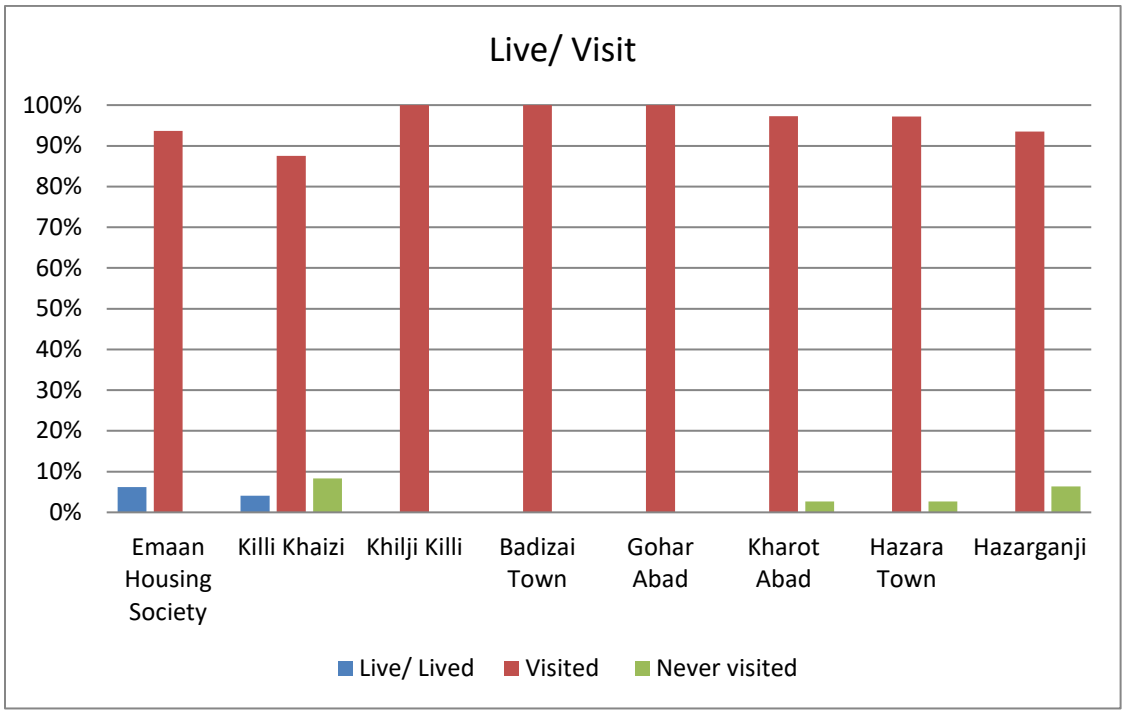

Figure 35 Live/ Visit (Western Bypass)

1.6.10 Raisani & Qambrani roads

Arbab Karam Khan road, Qumbrani and Sheikhan were marked 3 most known sub-areas located at Raisani and Qambrani roads (Figure 36). All of the sub-areas were also marked unsafe by most of the respondents (Figure 37).

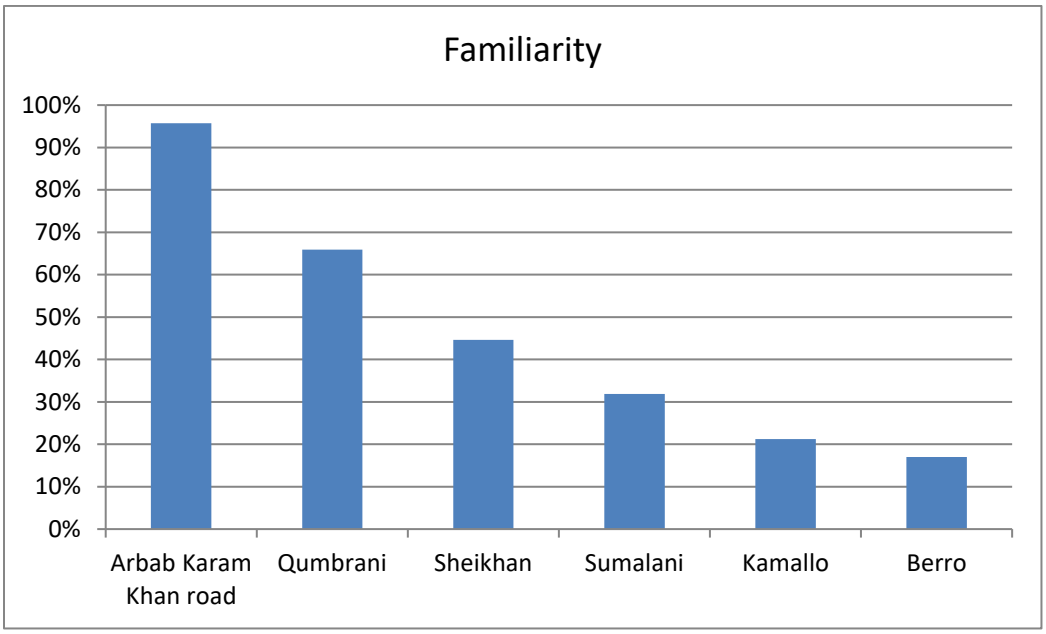

Figure 36 Familiarity of sub-areas (Raisani & Qambrani roads)

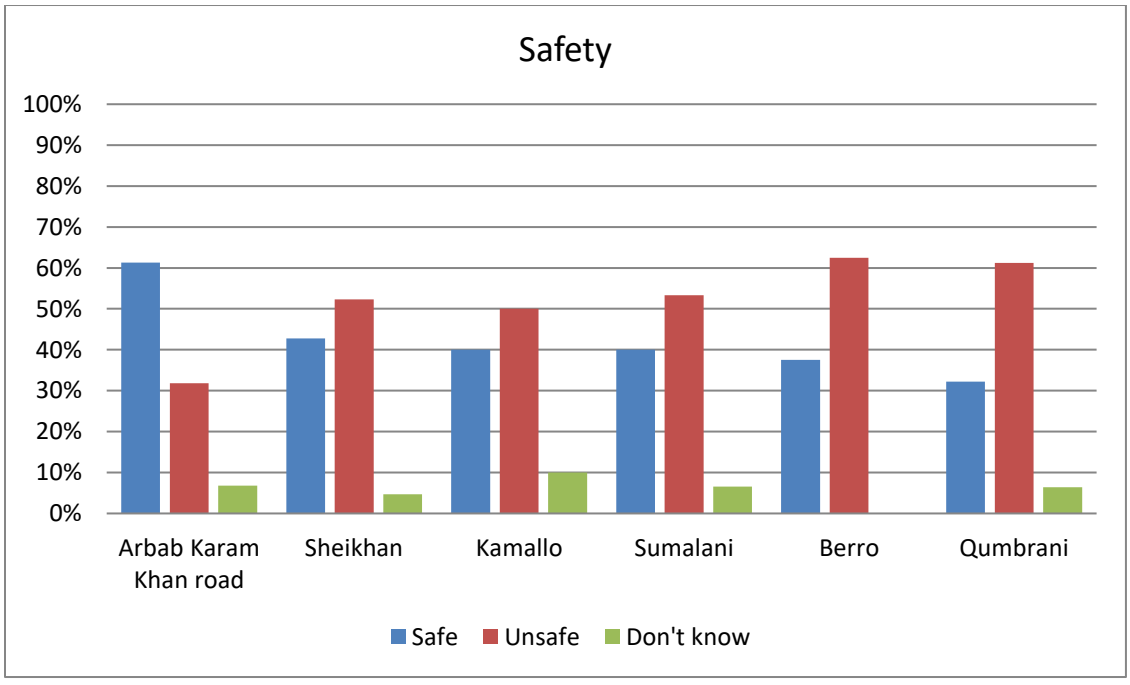

Figure 37 Safety of sub-areas (Raisani & Qambrani roads)

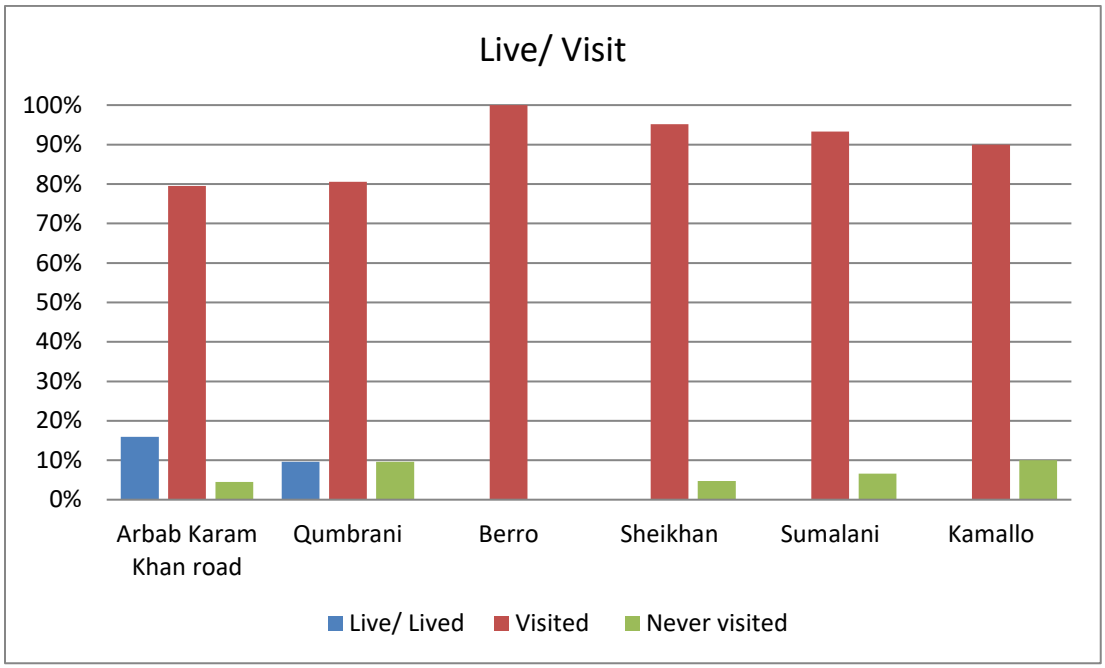

Figure 38 Live/ Visit (Raisani & Qambrani roads)

1.6.11 Eastern Bypass

Eastern Bypass got the least familiarity score out of all 11 areas. There are few planned housing schemes which are still in development stage. Mostly Pashtuns (Pathans) are living in the sub-areas of Eastern Bypass except New Baloch Colony and Rind Gar (Garh) which is one of the oldest neighbourhood of Quetta and considered village of Rind tribe of Baloch ethnic group. New Pashtun Abad is most famous sub-area (Figure **39**), and mainly all the sub-areas are marked unsafe by many respondents (Figure **40**).

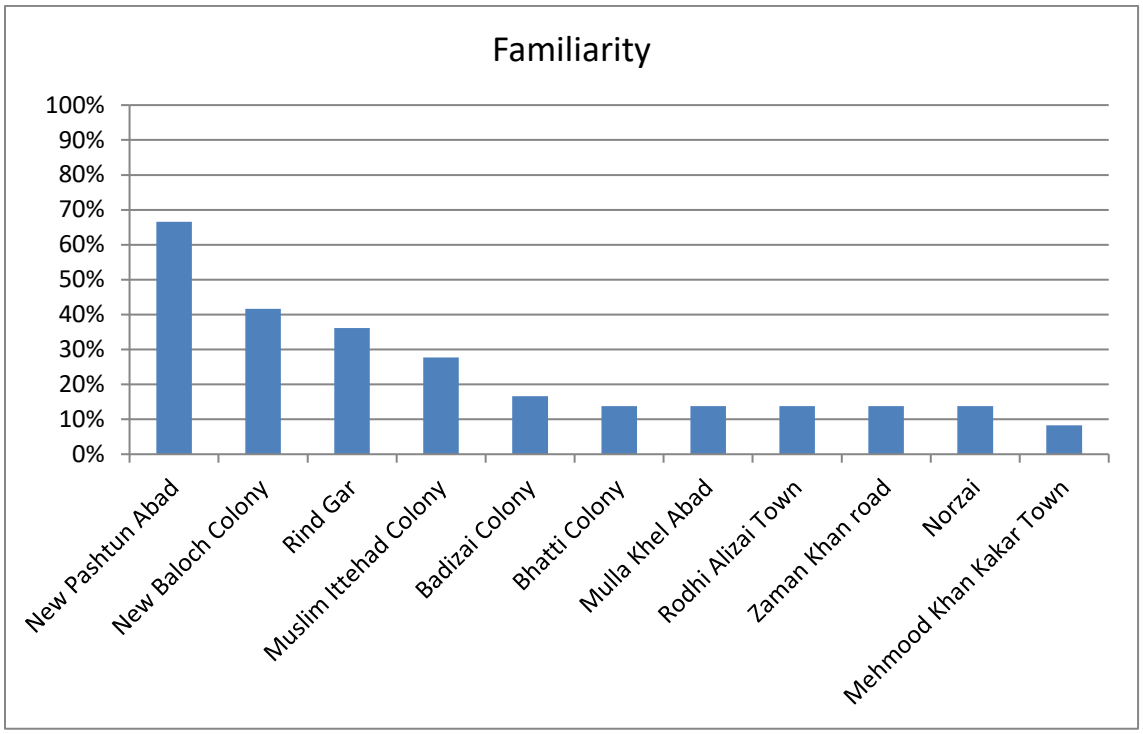

Figure 39 Familiarity of sub-areas (Eastern Bypass)

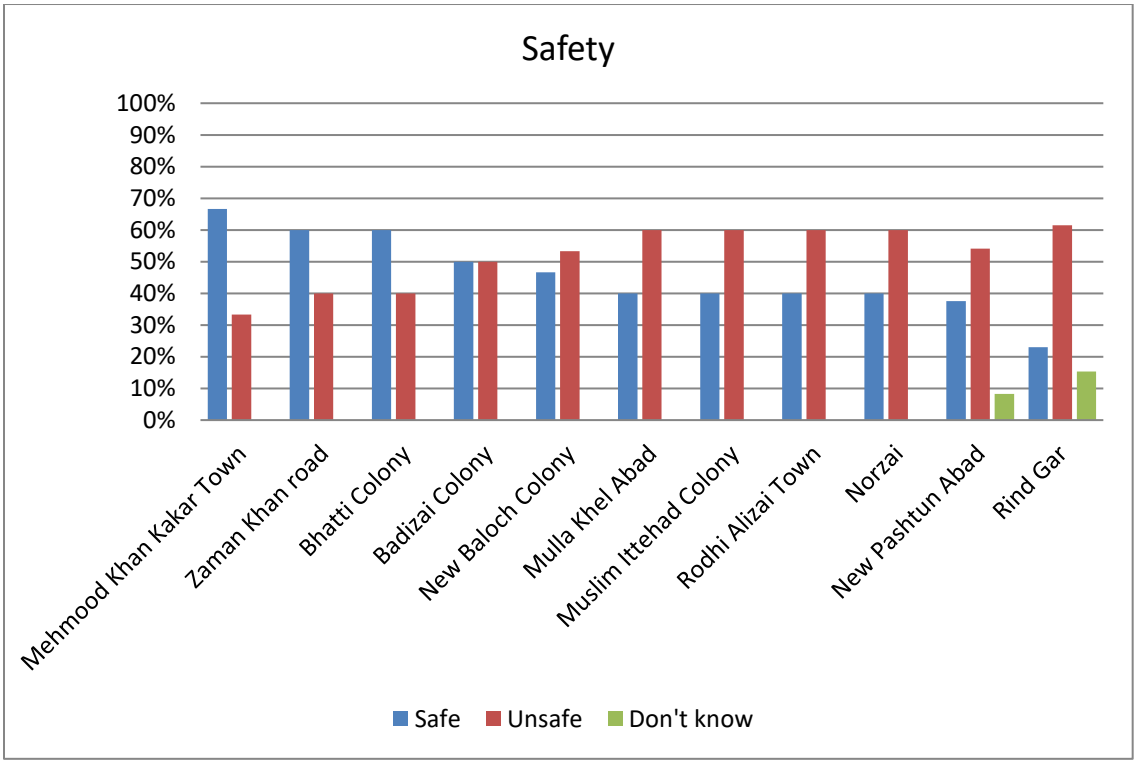

Figure 40 Safety of sub-areas (Eastern Bypass)

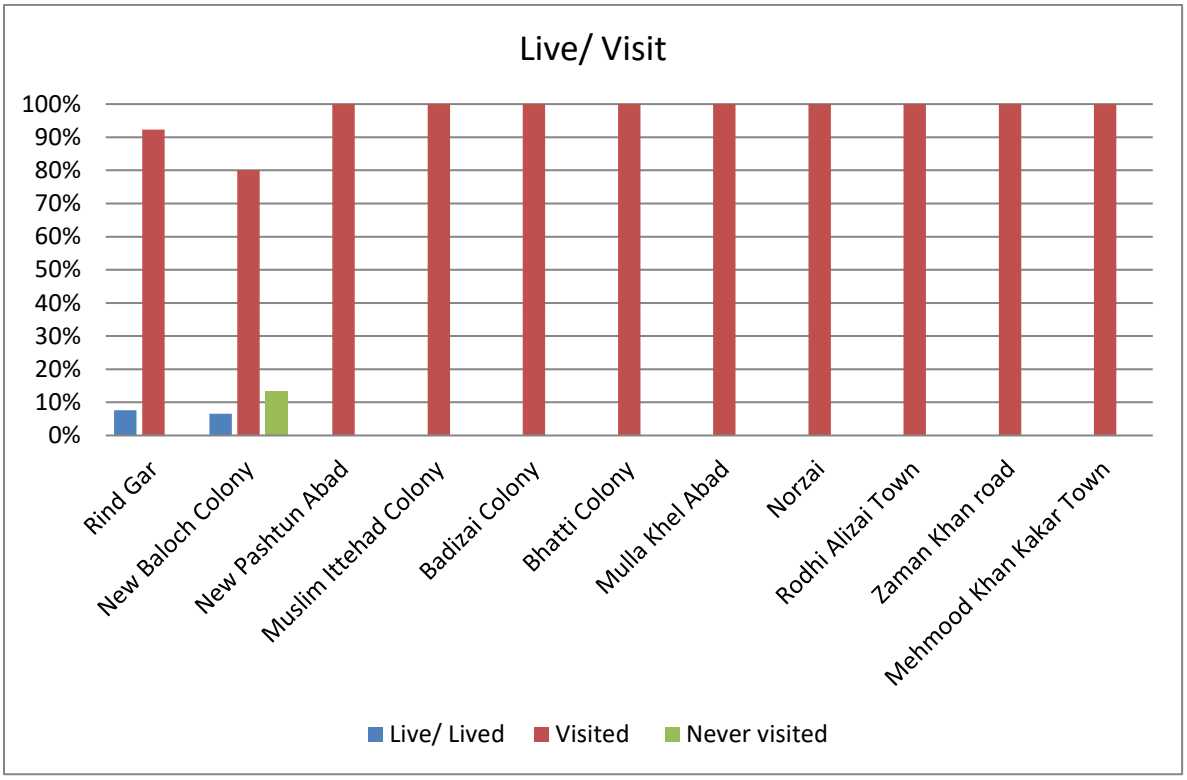

Figure 41 Live/ Visit (Eastern Bypass)

1.7 Conclusion

Looking at the all results displayed in figures from Figure 9 to Figure 41, initially the following 14 housing areas (Table **1**) were selected for the survey considering their familiarity, safety and type of contract (ownership). However, the areas of QESCO Colony and Garden Town were not included for the final survey due to unavailability of local resident/ contact. In addition to 12 residential areas which were marked safe, 20 more were included in the housing survey to get more representative sample of housing in Quetta city.

Table 1 List of safe areas

S. No	Housing area/ Colony	Area	Housing Type	Safety
1.	QESCO Colony	Airport & Baleli road	Public	Safe
2.	Chiltan Housing Scheme	Airport & Baleli road	Real-estate	Safe
3.	GOR Colony	Airport & Baleli road	Public	Safe
4.	Chaman Housing Scheme	Airport & Baleli road	Real-estate	Safe
5.	Garden Town	Airport & Baleli road	Real-estate	Safe
6.	Arbab Town	Samungli road	Owner occupancy	Safe
7.	Jinnah Town	Samungli road	Real-estate	Safe
8.	Shahbaz Town	Samungli road	Real-estate	Safe
9.	Model Town	City Centre	Real-estate	Safe
10.	Fatima Jinnah road	City Centre	Owner occupancy	Safe
11.	Prince road	City Centre	Owner occupancy	Safe
12.	Masjid road	City Centre	Owner occupancy	Safe
13.	CGS Colony	Double & Sirki roads	Public	Safe
14.	Ahmedzai Colony	Double road/ Sariab	Owner occupancy	Safe

2. Housing Survey

2.1 Problem statement

For the current PhD research as mentioned in the introduction, it was essential to identify the characteristics of existing housing in Quetta. For that a housing survey was conducted in 32 residential areas of Quetta city to prepare inventory of existing housing stock.

2.2. Goal

To find out the characteristics of existing housing in Quetta, i.e. construction type(s), materials, energy consumption, existing systems for water, electricity, gas, and sewerage.

2.3 Research Questions

- What is the common construction type(s) of houses in Quetta?
- What are the existing materials used for the construction of houses?
- What is the energy (electricity and natural gas) consumption of housing?
- What are the existing systems for water (supply, drainage)?
- What is the average income and wealth of a household?

2.4 Methodology

As the law and order situation in Quetta is unsatisfactory, a safety questionnaire was distributed online to identify the safe areas where it is possible to visit houses and conduct the survey. In order to get more representative sample size, it was decided to seek help from students and staff of BUITEMS University Quetta and practicing architects and engineers to fill the survey questionnaires in their respective residential areas or where it is possible. A survey questionnaire was designed based on English housing survey (EHS, 2015) and a PhD thesis of a research conducted on Pakistan (Naeem, 2009). The questionnaire was further modified after the discussion with experts from architecture, economics, and social sciences background. The residential areas were carefully selected in order to represent the various types of housing areas and people from major ethnic, religious and income groups who are living in Quetta city.

Table 2: Selected residential areas

S. No.	Residential Area	Area	Housing type	No. of houses surveyed
1.	Ahmedzai Colony	Double road/ Sariab	Safe/ owner occupancy	10
2.	Arbab Karam Khan road	Raisani & Qambrani roads	Middle income/ owner occupancy	3
3.	Arbab Town	Samungli road	Middle-High income/ owner occupancy	5
4.	Burma Hotel area	Sariab road	Slum/ squatter/ old	10
5.	CGS Colony	Double & Sirki roads	Safe/ planned/ public housing	10
6.	Chaman Housing Scheme	Airport & Baleli roads	Safe/ planned real-estate development	6
7.	Chiltan Housing Scheme	Airport & Baleli roads	Safe/ planned real-estate development	9
8.	Christian Town	Samungli road	Owner occupancy/ low cost	5
9.	Fatima Jinnah road	City centre	Owner occupancy	2
10.	GOR Colony	Airport & Baleli roads	Public housing	7
11.	Hazara Town	Western Bypass	Owner occupancy/ Slum/ squatter	9
12.	Jinnah Town	Samungli road	Real-estate development	9
13.	Kharot Abad	Samungli road	Owner occupancy/ Slum/ squatter	9
14.	Kasi Road	City centre	Owner occupancy	1
15.	Kechi Baig	Sariab road	Owner occupancy/ old neighbourhood	8
16.	Killi Almas	Airport & Baleli roads	Owner occupancy/ Slum/ squatter	2
17.	Killi Huda	Spiny & Joint roads	Owner occupancy/ Slum/ squatter	10
18.	Killi Shaboo	Airport & Baleli road	Owner occupancy/ Slum/ squatter	5
19.	Mariabad	City centre	Owner occupancy/ Slum/ squatter	20
20.	Masjid road	City centre	Owner occupancy	5
21.	Mc Conaghey road	City centre	Owner occupancy	1
22.	Model Town (Hali road)	City centre	Real-estate development	3
23.	Nawai Killi	New Hanna road	Owner occupancy/ Slum/ low cost	12
24.	Prince road	City centre	Owner occupancy	5
25.	Railway Housing Society	Brewery road/ Joint road	Real-estate development /Public housing	7

26.	Sabzal road	Brewery road	Owner occupancy	4
27.	Sariab road area	Sariab road	Owner occupancy	10
28.	Satellite Town	Sariab road	Real-estate development	10
29.	Shahbaz Town	Samungli road	Real-estate development	3
30.	Sundas Villas	Airport & Baleli road	Real-estate development	5
31.	Survey 144	New Hanna road	Real-estate development	5
32.	Wahdat Colony	Brewery road	Public housing	5
Total				**215**

These selected areas are also marked on the map of Quetta city (Figure **42**).

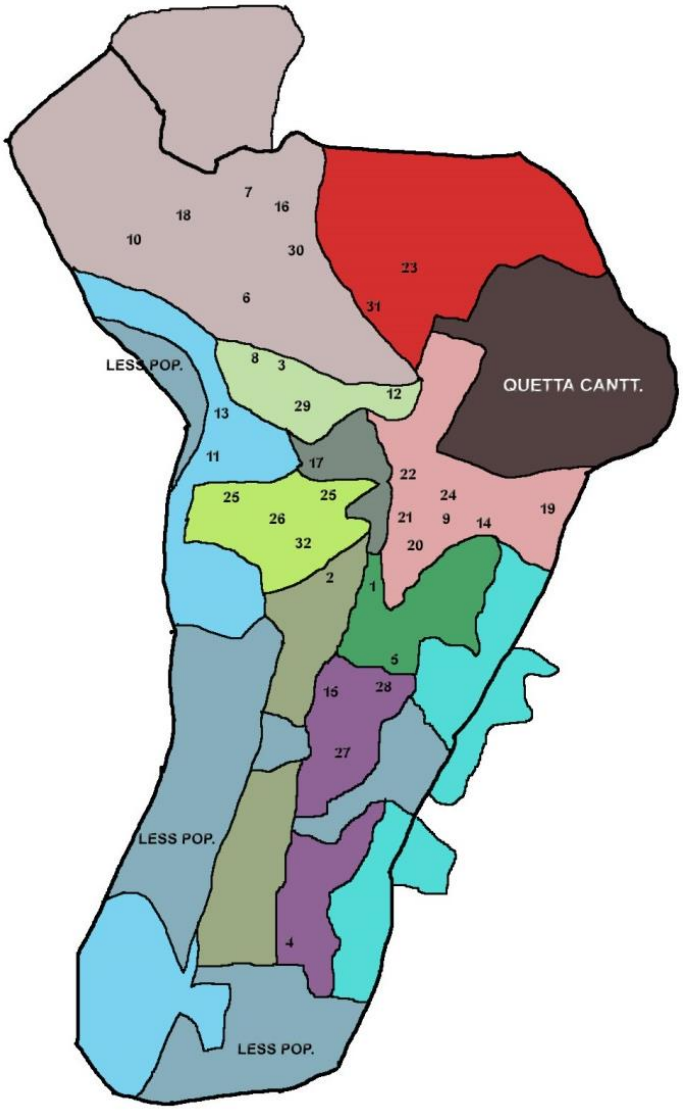

Figure 42 (Selected areas for housing survey)

Table 3: Residential areas and type of housing

S. No.	Housing type	No. of housing areas
1.	Owner occupancy	10
2.	Real-estate development	8
3.	Slum/ squatter/ owner occupancy	7
4.	Public housing	4
5.	Low cost/ owner occupancy	2
6.	old neighbourhood/ Owner occupancy	1
Total		32

The selection of residential areas is further shown in Table **3**, that states how various types of housing was included in the survey ranging from public housing to slum and squatter settlements. After the selection of residential areas, it was important to select the team to conduct the survey in selected areas. The most convenient way was to find the residents from each residential area who can speak the same language and can communicate easily with the residents. 3rd year and above students of Architecture (bachelor) from Department of architecture, BUITEMS Quetta were selected on voluntarily basis to help in the completion of survey. Initially survey was conducted in 5 residential areas by the students who live in the same area as a test to see what the response of the residents is? and if there is any need to change or skip any question in the questionnaire. After that, the survey was started in remaining 27 areas with the help of students and staff of BUITEMS University, practicing architects and non-government organizations (NGOs), Table **4.**

Table 4 Detail of survey team

S. No.	Surveyed by	No. of houses surveyed
1.	Students	125
2.	Architects	33
3.	Staff	27
4.	NGOs	30
Total		215

In total 221 questionnaires returned and after sorting 215 questionnaires were included for the result of this survey. The excluded 6 questionnaires were partly filled, and several questions were skipped or left blank.

2.4.1 Criteria for the selection of houses

Multiple criteria were used to select the houses for this survey which is mentioned below:

- Every 5th house on each side from an identified landmark in public housing schemes or planned housing developments
- Selection of houses from different streets
- Representative number of houses from each block/ sector if there are more than one blocks, sectors or phases in a housing area
- Representative number of houses for each housing/ construction type
- Willingness or consent of the residents
- Representation of major ethnic, cultural, religious and income groups

A wealth or assets level table was developed and further divided based on Need and Luxury, each list consists 11 items/ facilities available in a household, this wealth level is a proxy indicator gives more insights about household wealth. The complete list of household wealth, assets or items present in a household is given in Table 5.

Table 5 List of Household wealth/ assets

S. No.	Household wealth/ assets	
	NEED	**LUXURY**
1	Electricity	Charpai/ local bed
2	Natural gas	Bed
3	Fan/ Air Cooler	Dining table
4	Press Iron	Sofa/ couch
5	Room heater	Microwave oven
6	Mobile phone	Vacuum cleaner
7	Television	Air-conditioner
8	Washing machine	Computer
9	Water geyser/ boiler	Internet connection
10	Refrigerator	Car
11	Motorcycle or scooter	Domestic servant in household

The results of this survey were classified as following:

- Socio-demographic data
- Household characteristics
- Construction types

3. Socio-demographic data

The socio-demographic data contains the information about year of construction, mother tongue, family, and plot size; qualification, employment status and nature of job of head of the household; number of levels/ floors and bed rooms, household income and wealth level.

3.1 Year of Construction

As shown in Figure 43 most of the surveyed houses were constructed during the last 40 years, of which most even in the last 2 decades: 69 houses were built during 1997-2006, and 50 houses were constructed during 2007-2016. This could be related to the fact that many refugees moved

to Quetta due to War in Afghanistan (2001-2014), and that during the last 2 decades new housing schemes were developed in the northern part of Quetta city. The following figure shows the result of 189 houses while 26 respondents given no answer.

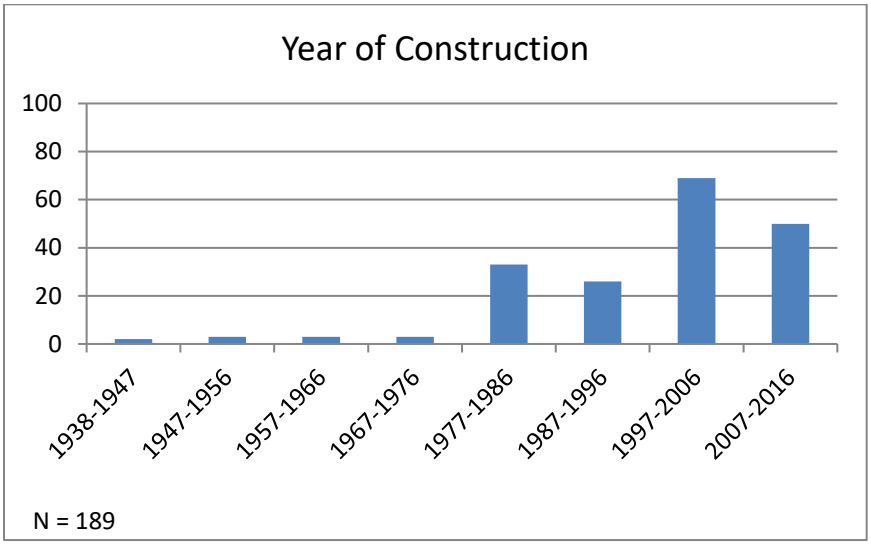

Figure 43 (Year of Construction)

3.2 Mother tongue

To get insights about the population living in the selected areas of Quetta, the respondents must mention their mother tongue. The result of the responses can be seen in Figure 44. It shows that most of the households speak Pashto (34%), Punjabi (15%), Hazargi (13%), Urdu (12%), Brahui (9%) and Balochi (7%).

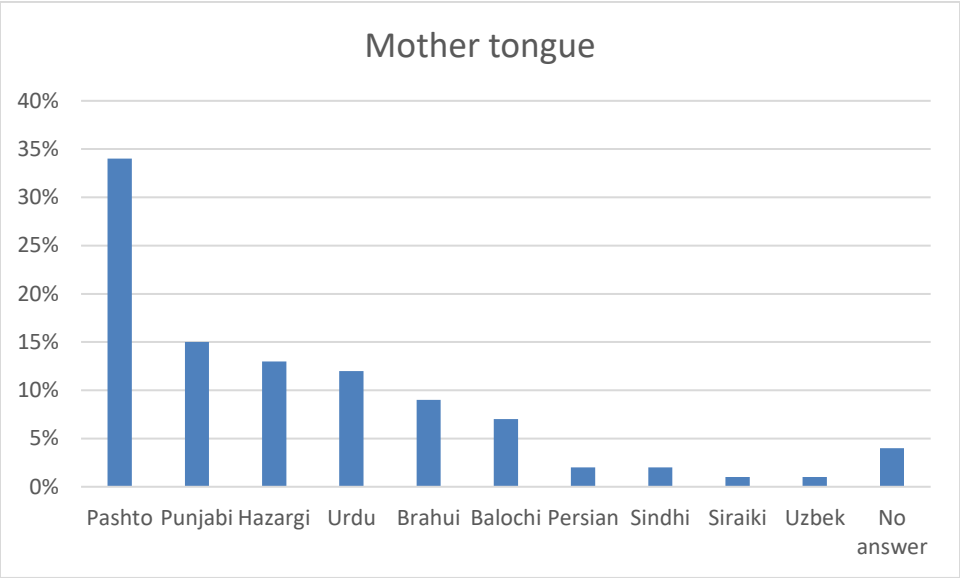

Figure 44 (Mother tongue)

3.3 Family size

The total population covered in the survey of 215 houses was 2,136 persons, with an average household size of 9.9 persons per house. The family size varied between minimum 2 person and maximum 40 persons (Figure 45), but families of 5 to 6 persons were most represented (64 households or 29.7%).

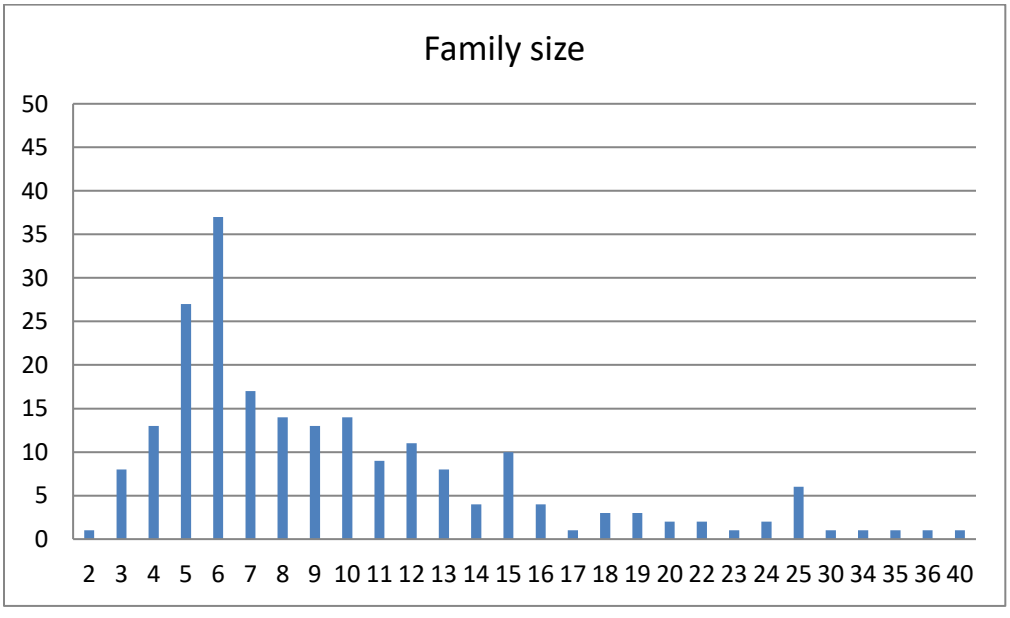

Figure 45 Family size

3.4 Plot size

In Pakistan, plot size or area of the house is usually measured in square feet (sq. ft.). The results of this survey show that the smallest house has a total area of 300 sq. ft. (27.8 m^2) and the largest house has a total area of 22, 500 sq. ft. (2090.3 m^2) whereas 18 households did not give any response. To simplify the data, it is shown in 2 separate graphs. In Figure 46 plot sizes are shown with a difference of 100 sq. m. It can be seen that 71 houses had a total plot size/ area between 100-200 m^2.

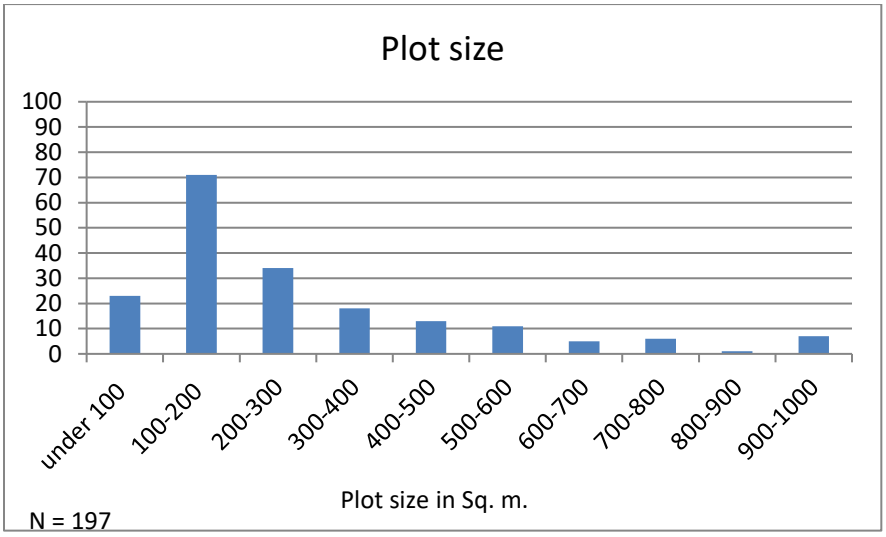

Figure 46 (Plot size under 1000 m^2)

Only 8 houses out of 197 had a plot size over 1000 m^2 which can be seen in Figure **47**, where 3 houses have total areas between 1000-1300 m^2, 4 houses have total areas between 1300-1600 m^2, and only one house had an area between 1900 m^2 to 2100 m^2 .

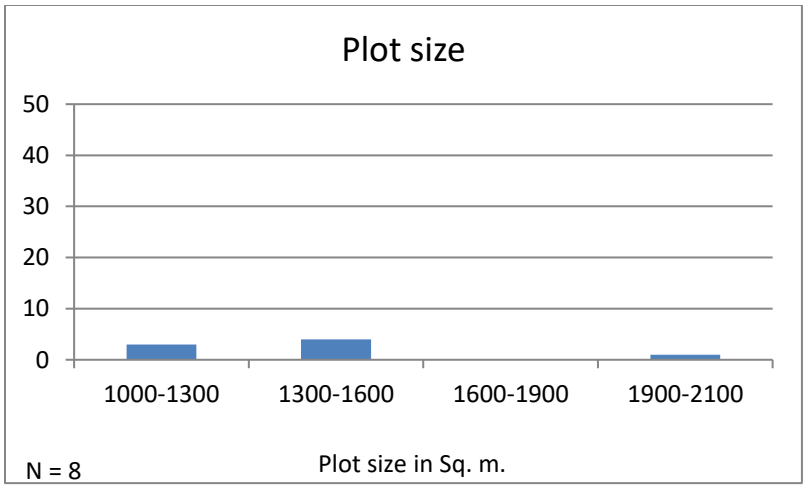

Figure 47 (Plot size over 1000 sq. m.)

3.5 Qualification of the head of the family

The survey included a question about the educational qualification of the head of household. It can be seen in (Figure **48**) that most of the respondents possess a bachelor (33%) or master's degree (21%). However, 7% of the respondents said that they were uneducated.

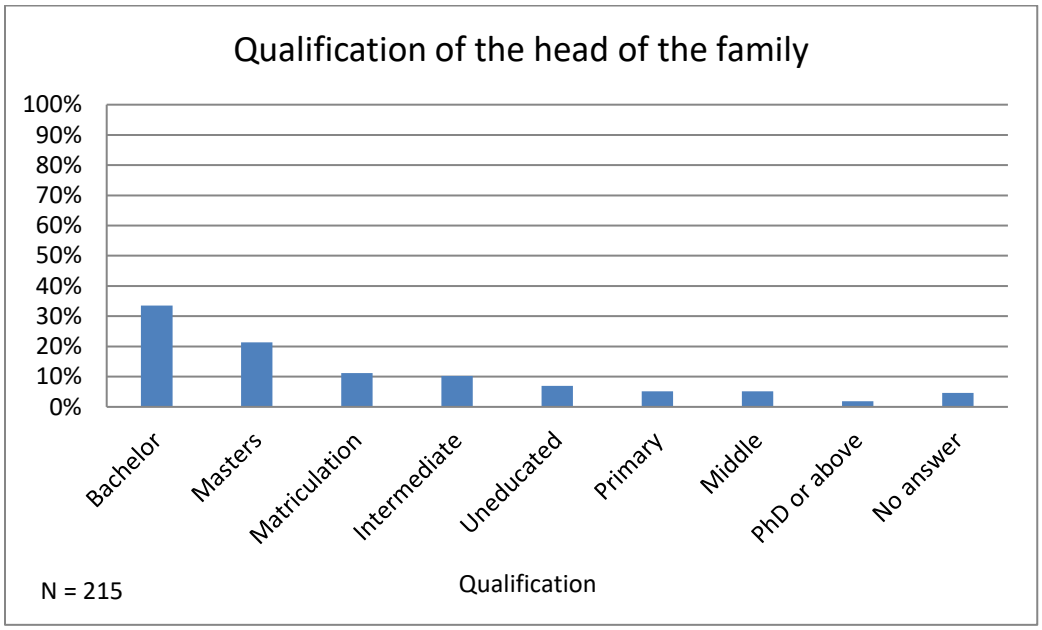

Figure 48 (Qualification of the head of the family)

3.6 Employment

Figure 49 shows the employment status of the head of household. Majority of the respondents (94%) marked that they were employed. The people, who marked themselves unemployed, mentioned that they are retired in the next question which was related to the nature of job, while the ones who did not gave any answer mentioned that they were landlords in the next question.

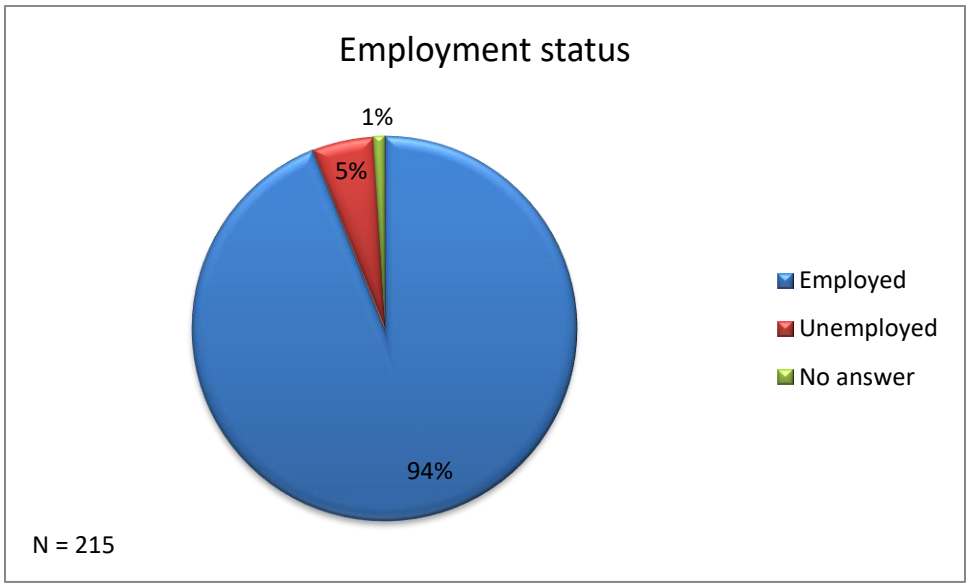

Figure 49 (Employment status)

3.7 Nature of Job

After the question about employment status, there was a question about nature of job and the respondents could choose between salaried, business, self-employed, daily wages and 'other' (with the possibility to enter their own response). Figure 50 shows that majority of the respondents were salaried or were doing business.

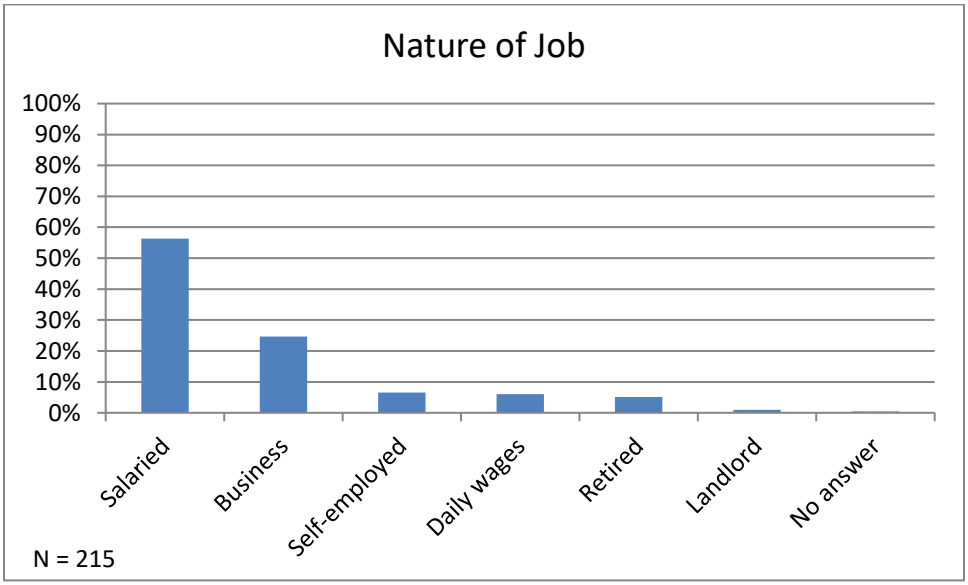

Figure 50 Nature of Job

3.8 Levels/ Floors

It can be seen that most of the houses only had one or two floors or levels (Figure **51**). In the sample of 215 houses only 2 houses found with basement floor.

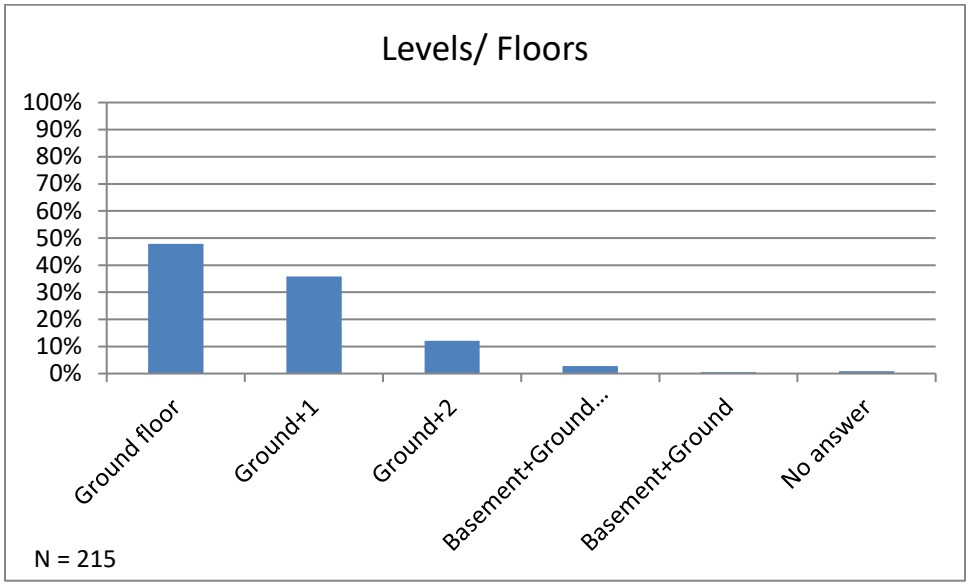

Figure 51 Levels/ floors of the houses

3.9 Bedrooms

In total there were 997 bedrooms in 215 houses, which represent average room occupancy of 2.18 persons per bedroom. The sample contains houses with minimum 1 bedroom to maximum 18 bedrooms. Most of the households consist of 2-6 bedrooms, as shown in Figure **52**.

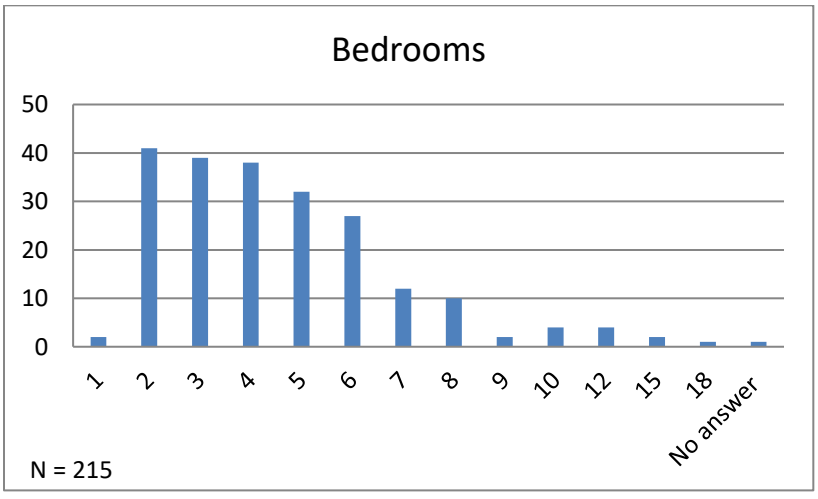

Figure 52 No. of Bedrooms

3.10 Household Income

In question regarding household income, 6 choices were given, and respondents had to select the average income level rather than providing exact income. The result shows that 30% of the households earn between €143-402 per month (Figure 53) and 27% of households earn between €411-€715 per month while 6% of the households earn less than €134 (PKR 15,000).

* Result is converted from PKR to EUR for better understanding, assuming 1EUR= 111.42 PKR.

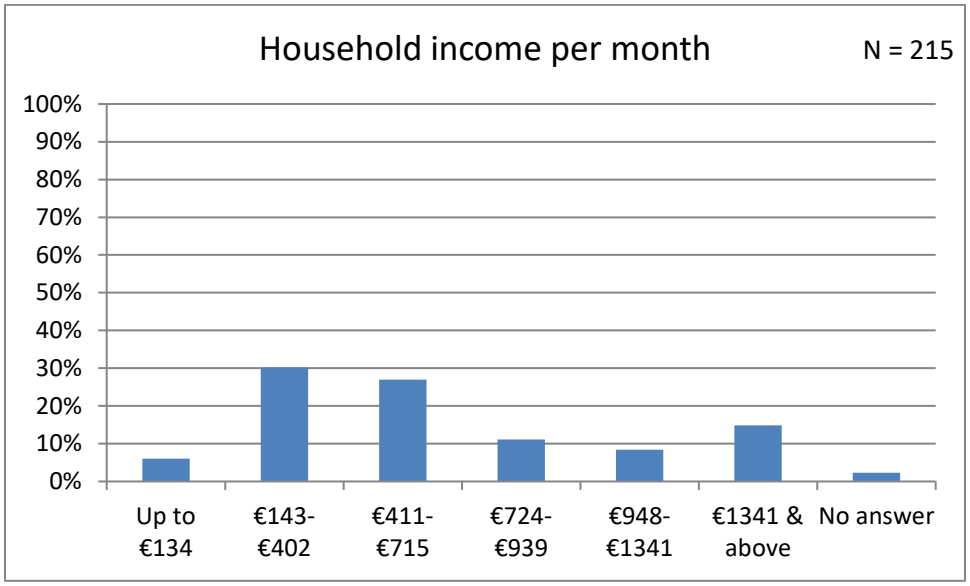

Figure 53 Household income per month

3.11 Household wealth

To evaluate the household wealth a wealth level table was formed consisting of 22 items and asking the respondents whether they have/ use that item/ facility in their house or not. It was further divided based on luxury and comfort, consisting 11 items in each. Figure 54 and Figure 55 describes the items of wealth level table based on need and luxury. All 215 houses had electricity connection while 210 houses were connected to gas supply line. 98% of the households had fan and mobile phone. Television was available in 93% of the households as families with more religious and radical background do not prefer to have a TV in their houses.

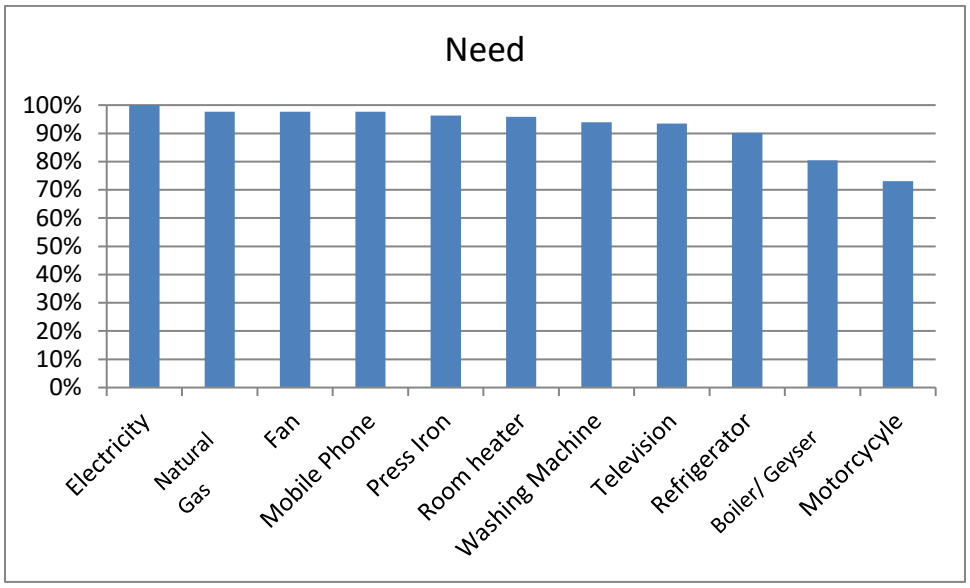

Figure 54 Wealth Index (Need)

More houses had computer 80% than internet connection 72%. Sofa or couch was available in half of the houses (50%), but dining table was in only 32% houses. One of the reason could be that there is a tradition in Quetta that people take their meals while sitting on ground that is why they do not prefer dining table. They use very nice rugs and carpet to sit on in their houses.

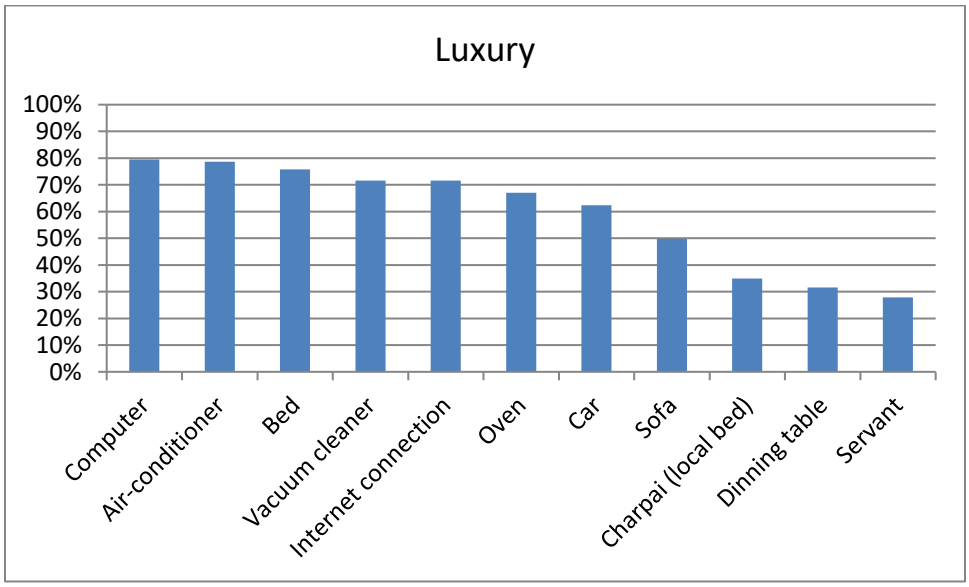

Figure 55 Wealth Index (Luxury)

4. Characteristics of Houses

This section covers the results of characteristics of houses such as structural system, materials used for construction and finishing etc. It gives an overview of the common materials and structural systems which is then further classified for each structural system(s).

The houses were categorized by structural system (super-structure).

4.1 Structural system

In Figure **56** it was found that majority of the houses (65%) were composed of R.C.C (reinforced cement concrete) structure and then Brick masonry construction (31%) and Sundried bricks (5%).

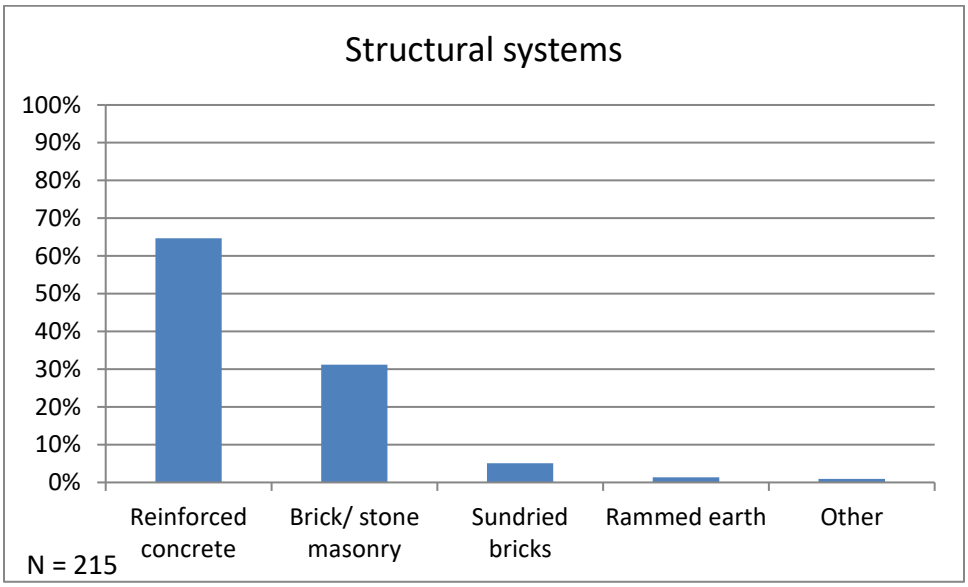

Figure 56 Structural Systems

4.2 House Design

Only 25% of the houses out of total sample of 215 houses were designed by architect (Figure **57**). Most of these houses were built during last 10-15 years. 10 households responded that the house was designed by the owner of the house, but it was not clear that whether the owner is architect or have similar qualification so that these houses are also included in the houses which are not designed by architect. It is common that in many residential areas the owner provides his/ her requirements to the contractor/ mason and they draft a rough plan and build the house based on that rough draft. According to Quetta Development Authority (QDA) permission of building plans

is necessary but authority is not actively checking the construction and development process in the city.

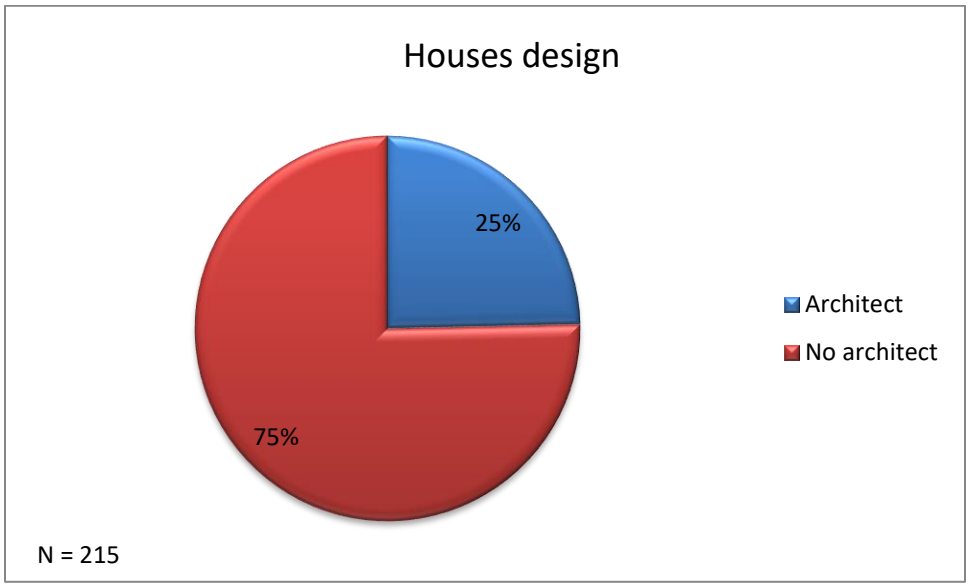

Figure 57 (House design)

4.3 Walls

In order to analyse the walls, 3 questions were included in the questionnaire asking information about thickness of walls, main materials of walls and finishes.

4.3.1 Wall Thickness

The respondents gave various answers about the thickness of walls. The question was asked for both exterior and interior walls. Following Figure **58** shows the responses about the thickness of walls.

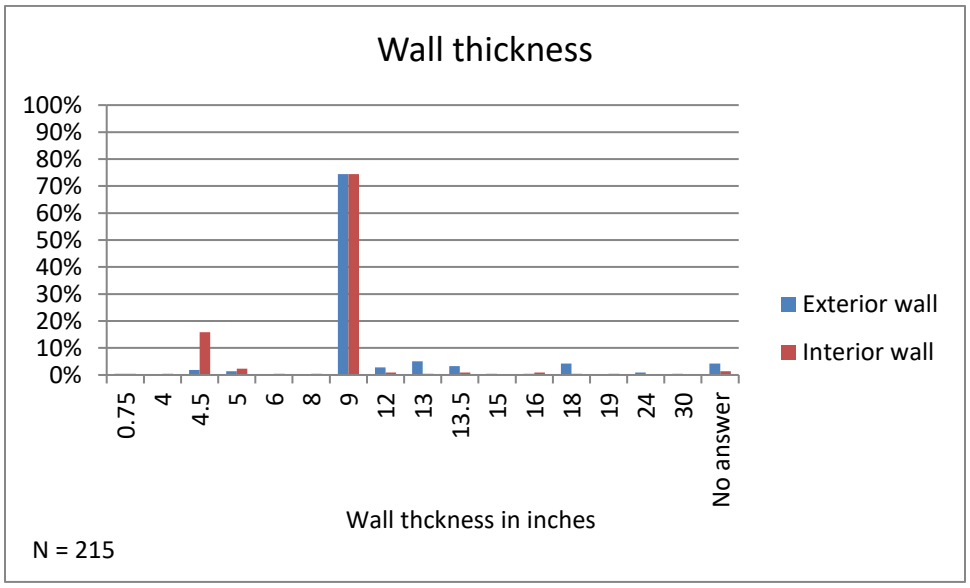

Figure 58 Wall thickness

The average size of brick in Pakistan is 4.5”x9”x3” (11.4 cm x 22.8 cm x 7.6 cm). That means the possible thicknesses of walls could be: 4.5”, 9”, 13.5” (9”+4.5”), 18” (9”+9”) etc. So, it can be concluded from Figure **58** that some of the mentioned wall thicknesses were not realistic. Therefore, the data are rearranged according to the possible thicknesses of walls, which can be seen in Figure **59**.

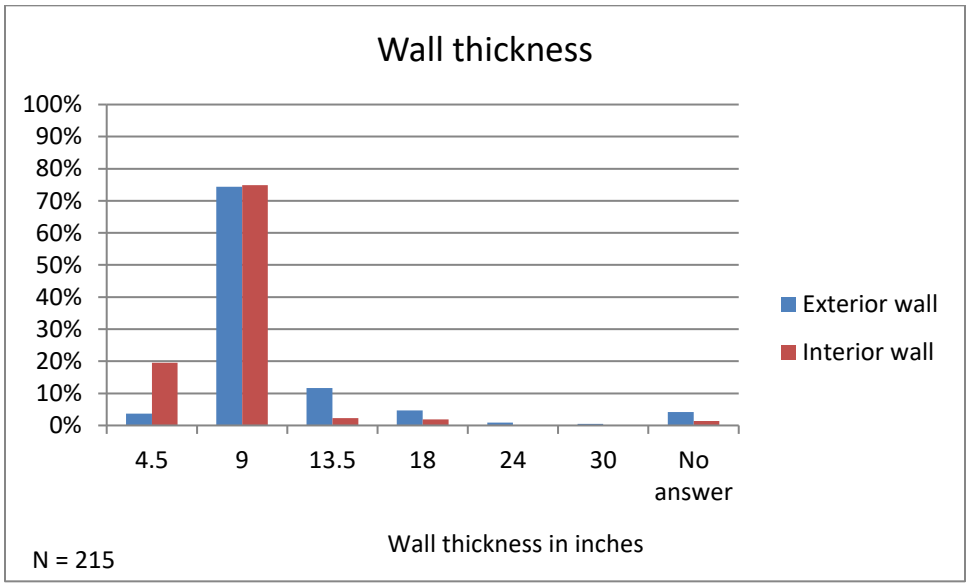

Figure 59 Wall thickness (modified)

The above figure shows that the most common wall thickness was 9” (22.8 cm) for both exterior and interior walls.

4.3.2 Exterior walls

There were 2 questions about exterior walls, main material of exterior walls and finish of the exterior walls. Figure 60 shows the main materials of exterior walls. Multiple answers were possible for this question. Mostly walls are constructed of baked bricks with cement or mud mortar. Some respondents did not mention the type of mortar and simply answered that exterior walls are mad of baked bricks.

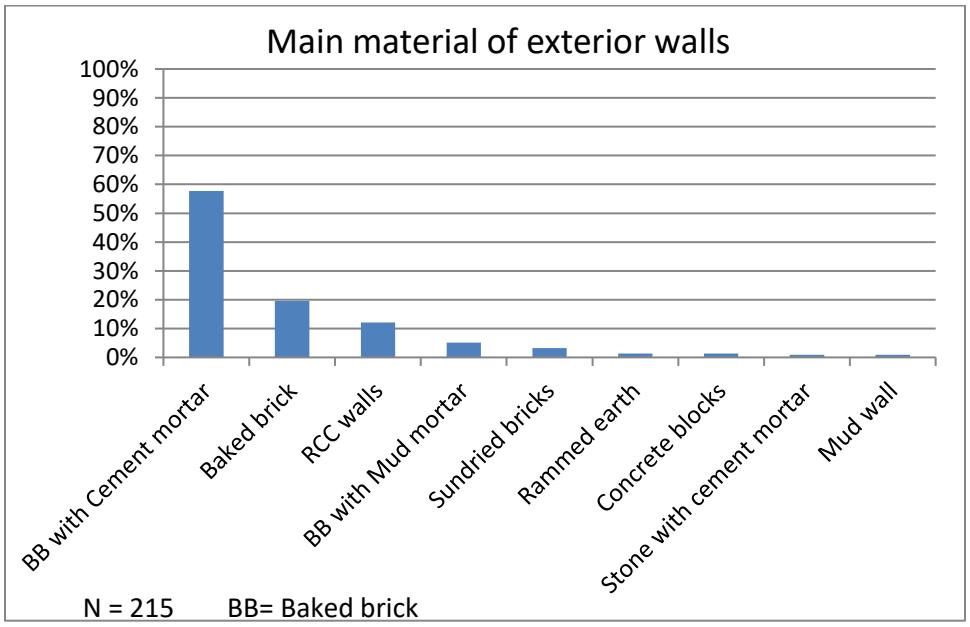

Figure 60 Main material of exterior walls

For exterior walls finishes, multiple answers were possible. In 50% of houses the exterior walls were painted and 45% houses used cement plaster as wall finish (Figure **61**)

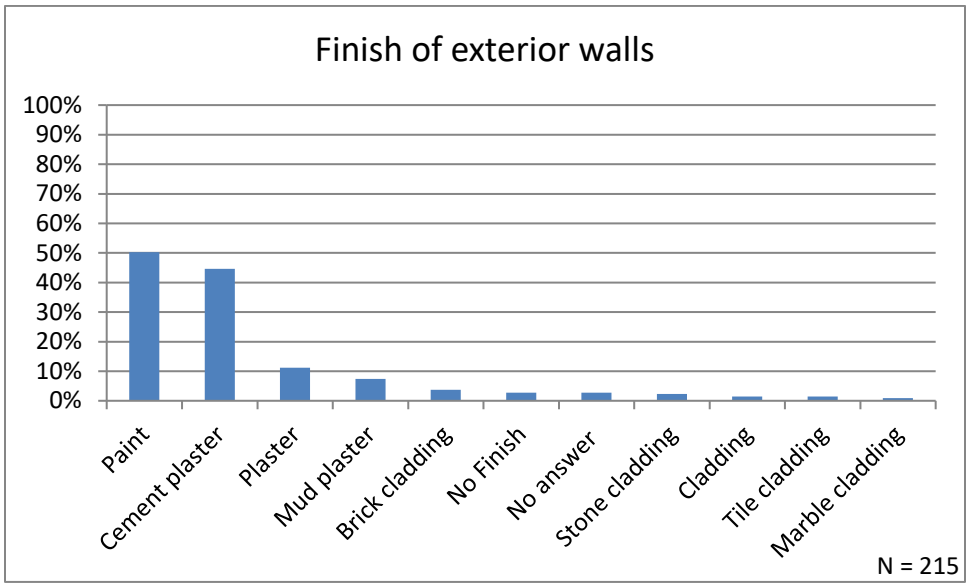

Figure 61 Finish of exterior walls

4.3.3 Interior walls

The material used for exterior or interior walls is usually same, but finishing can be different. Details about finishing of interior walls can be seen in Figure 62 that 70% of the respondents replied that walls were painted and 50% replied that walls are finished with cement plaster. Multiple answers were possible, so a wall finish can be combination of one or more of the following finishing type(s) or materials.

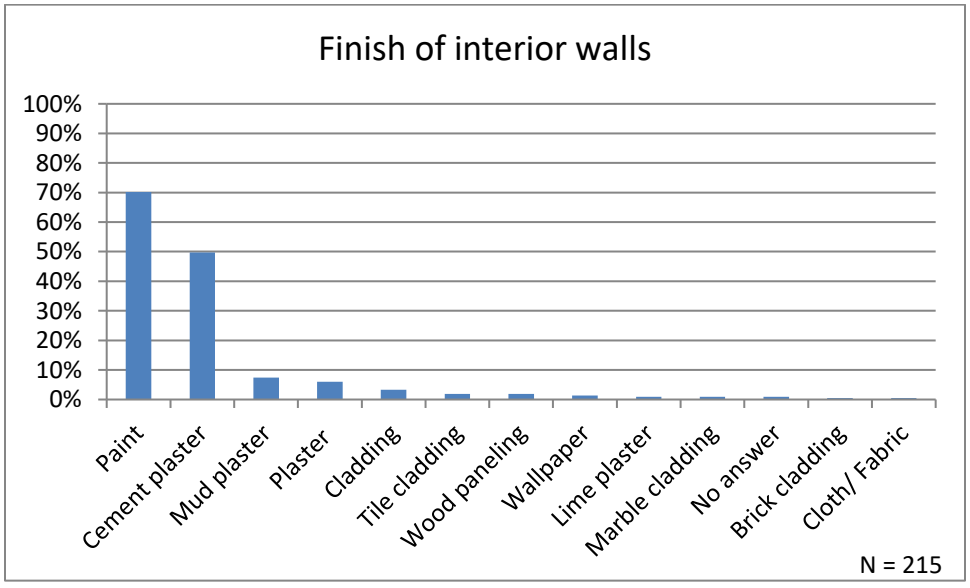

Figure 62 Finish of interior walls

4.4 Floor

For the floor, similar to the walls there were also two types of questions, one regarding main material of the floor and second about floor finishing. In Figure **63** it is represented that the most common material of floor was Plain cement concrete (PCC).

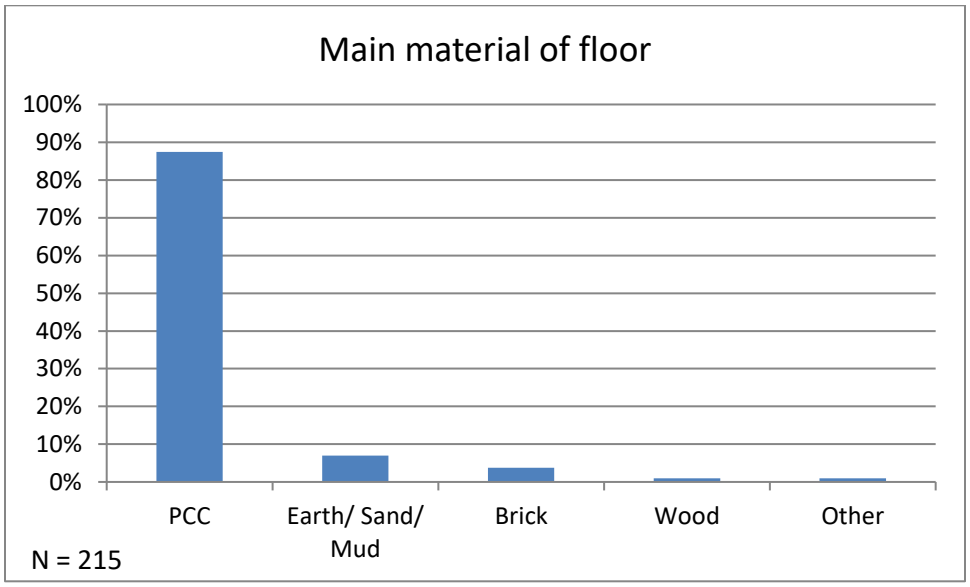

Figure 63 Main material of floor

Figure 64 shows the details of floor finishes. It was found that most common floor finish was PCC, then marble and Chip or Terrazzo. In many houses people use Carpet, mats, or rugs to cover the floors. Multiple answers were possible for this question as in a house more than one finishes can be used for floors of courtyard, rooms, kitchen etc.

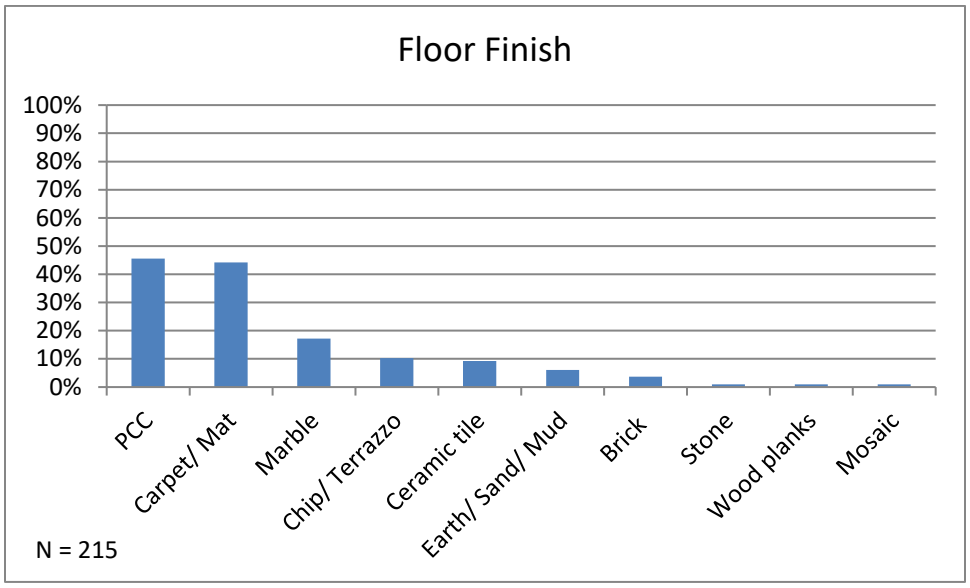

Figure 64 Floor Finish

4.5 Roof

Roof is another important building component for which the data was collected in this survey. The questions were divided into, main material of framing, roof covering and false ceiling. 80% of the roof framing were constructed of RCC beams and 12% used girders/ t-iron (Figure **65**).

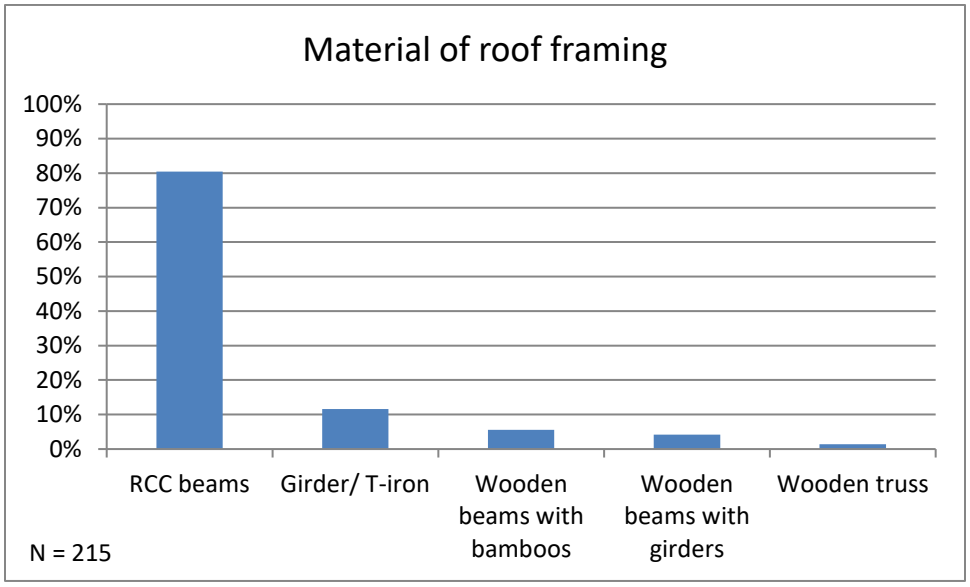

Figure 65 Material of roof framing

As discussed by (Mengal & Mahar, 2018) a T-iron and girder roof is commonly known as “Tier-Gaarder” roof. In this type of roof, I-shaped iron girders are first places over the columns or wall then T-shaped iron section bars are placed over the I-shaped girders. Terracotta roof tiles are then placed on the T-shaped iron bars. A plastic sheet is mostly placed over the terracotta roof tiles to insulate the roof against the rainwater. Then mortar is placed to finish the roof construction and insulate the roof against the heat.

Looking at the roof covering mostly it was RCC slab then burnt brick roof (terracotta) tile. 4% of the houses got corrugated galvanized iron (CGI) sheets as roof covering and only 1% of the houses used Reinforced brick concrete (R.B.C) as a roof covering material, as shows in Figure **66**.

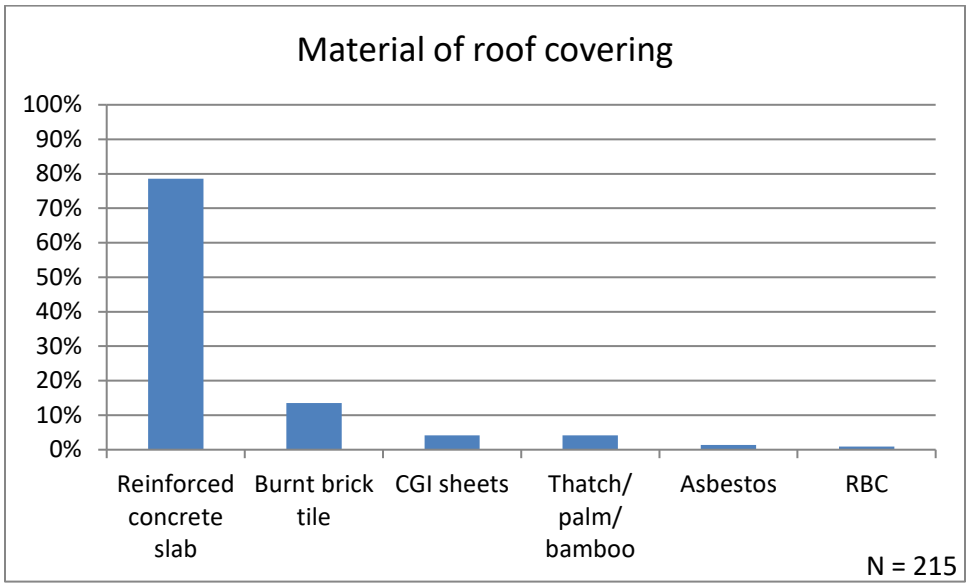

Figure 66 Material of roof covering

Out of 215, 91 households responded that they used false ceiling in their houses. The respondents had choice to selected more than one option. Most commonly used material for false ceiling in 91 houses was gypsum (locally known as Plaster of Paris), while wooden and cardboard sheets, mud, PVC (Polyvinyl chloride), polystyrene was also used (Figure **67**).

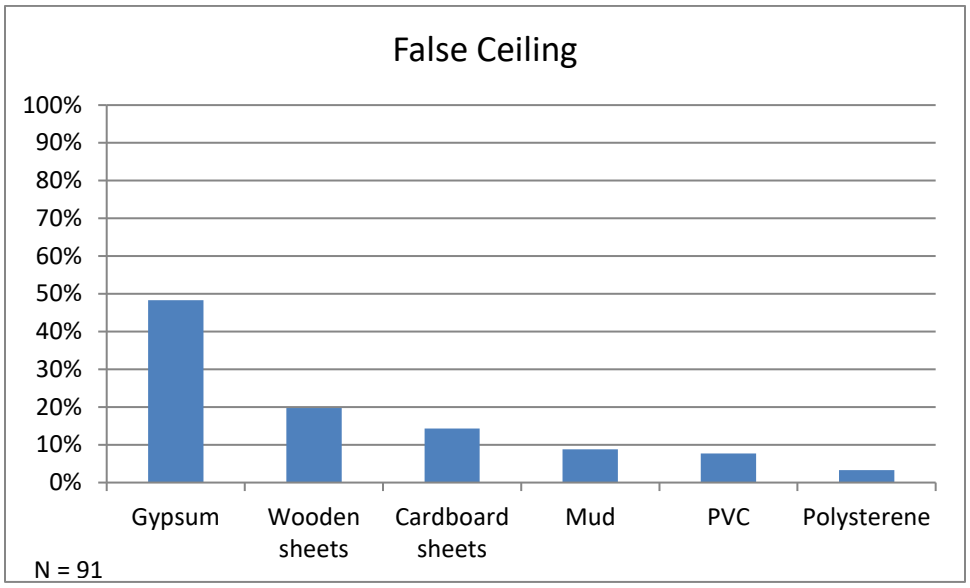

Figure 67 False ceiling

4.6 Insulation

It can be noticed that insulation is not commonly used in the houses at Quetta, only 11% of the houses out of 215, have insulated walls, roofs, or floors as shown in Figure **68**.

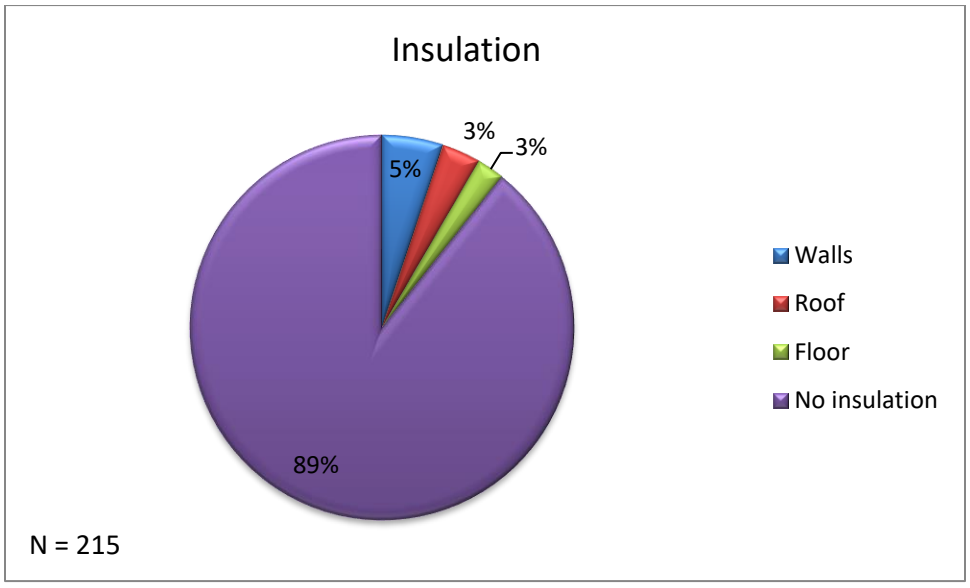

Figure 68 Insulation

4.7 Window glazing

The following Figure **69** shows that most of the houses used single glazed windows. Only 2% of households responded that they use triple glazed windows, considering the housing construction practices in Quetta, it is may not be possible to find any house with triple glazed windows since double glazed windows have also been introduced during last 10-15 years.

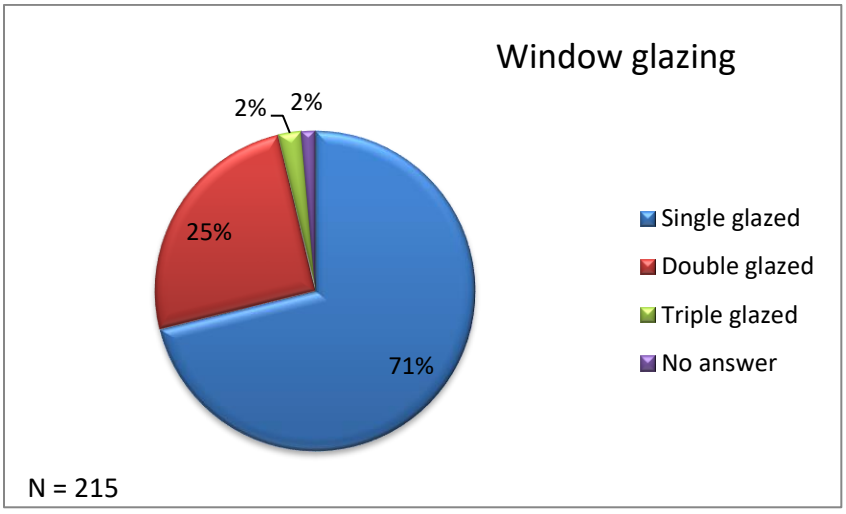

Figure 69 Window glazing

4.8 Energy

4.8.1 Heating

For heating, 2 questions were asked from the respondents; one about source of heating and second about the heating system used in the houses. Figure **70** shows that major source of heating is natural gas and only 5% of houses use electricity to heat their rooms, while 2% use wood/ coal/ dung.

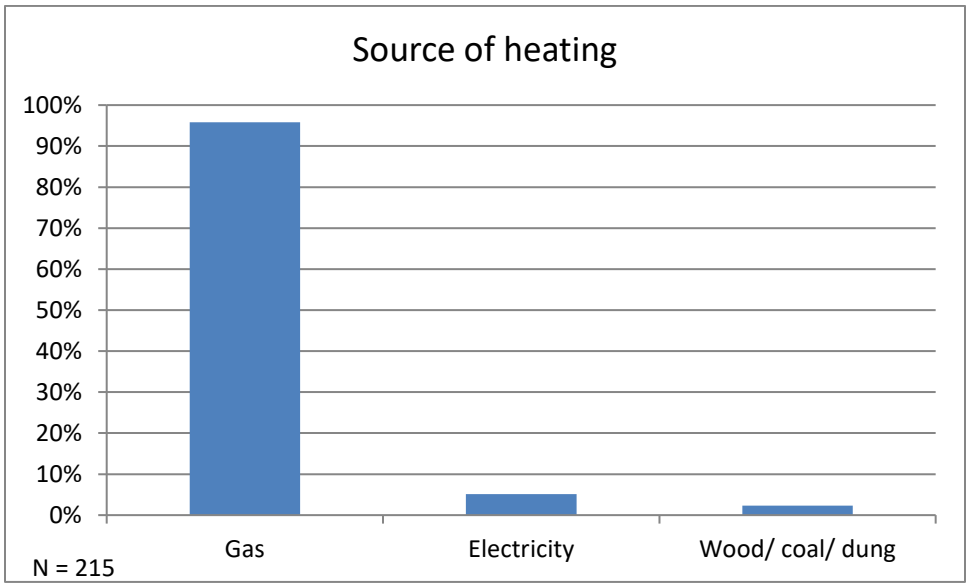

Figure 70 Source of heating

Central heating system was not common in Quetta (Figure **71**), some houses built during last decade use central heating system, yet majority of the houses use gas heaters to directly heat the rooms and indoor spaces.

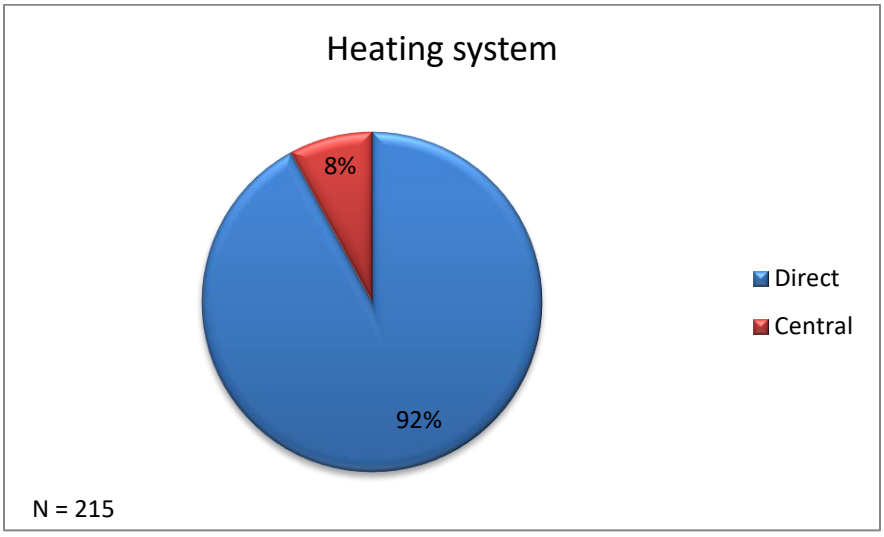

Figure 71 Heating system

Two types of heaters or heating devices are usually used for this purpose which can be seen in Figure **72** and Figure 73. The heating device shows in Figure 72, consumes natural gas while the

one in Figure 73 is operated on both natural gas and electricity. If one of them is not available this heating device will not function. Due to electricity outage hours in Quetta this device cannot be used through the cold day. Residents of Quetta mainly use first type of heating devices, since the natural gas is mostly available throughout the cold season. However, first type of device is not good for indoor air quality as it involves the process of combustion which produces carbon.

Figure 72 Gas heater

Figure 73 Gas cum electricity heater

4.8.2 Electricity

In order to see the usage of electricity, questions were asked from the residents regarding their energy bill to select a response from a given range of amount. It is also easier to remember the amount of bill rather than remembering electricity usage in kWh. Quetta Electric Supply Company (QESCO) is the only electricity distribution company in Balochistan, except some parts of the province get electricity from K-Electric Limited (formerly Karachi Electric Supply Company Limited).

In Quetta, usage of electricity is higher in summer season as compare to winter and each household pay more bill in summer than what they pay in winter. One of the reason is usage of

cooling devices, i.e. fans, air coolers, air-conditioners increases the usage of electricity in summer. Figure **74** shows that most of the household pay €27-€45 during summer.

Note: Data is changed to Euro from PKR (Pak rupees) for better understanding, considering 1Euro = 111.42 PKR.

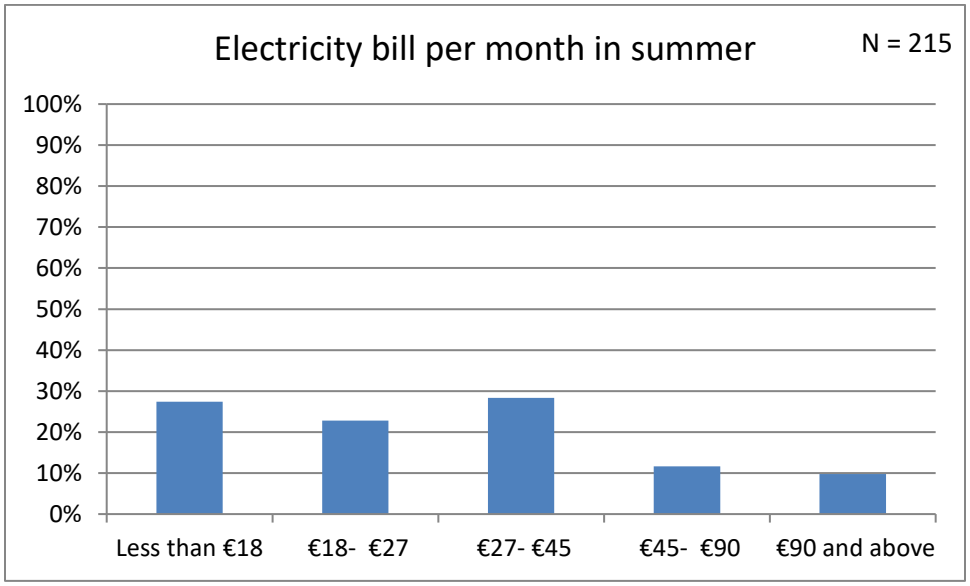

Figure 74 Electricity bill per month in summer

Electricity usage gets reduced in winter and most of the consumers pay less than €9 (Figure **75**) in winter season.

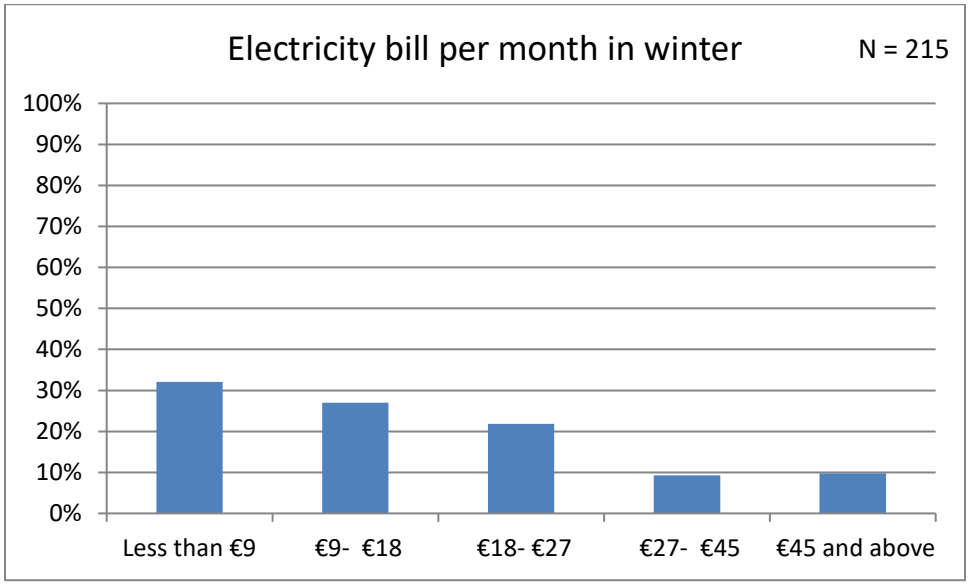

Figure 75 Electricity bill per month in winter

4.8.3 Natural Gas

Natural gas in Quetta is provided by Sui Southern Gas Company (SSGC) Limited. Gas is mainly used for heating as mentioned in Figure **70**. The usage of gas in summer is lower (Figure **76**) and most of the households pay €4.5-€9 per month for their gas consumption.

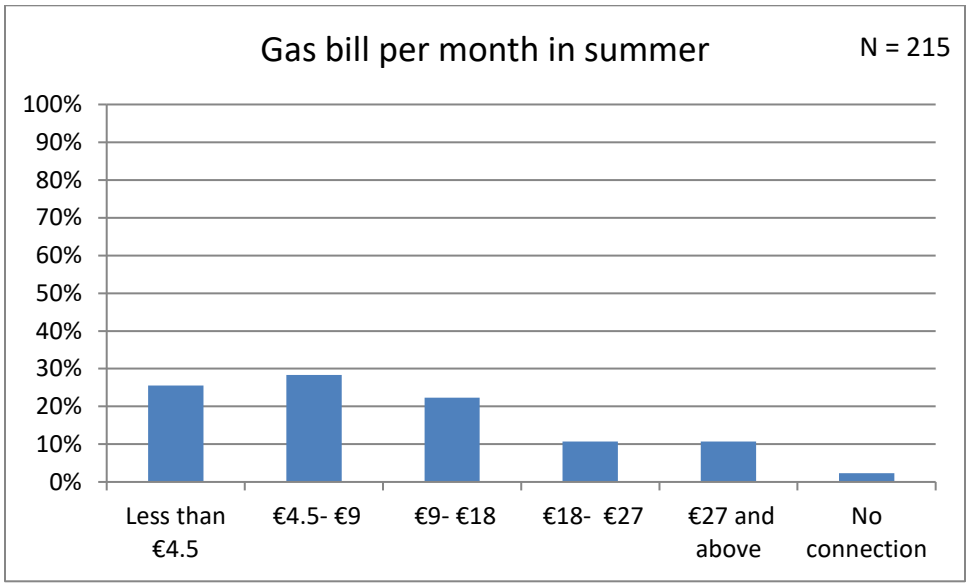

Figure 76 Gas bill per month in summer

The use of gas increases in winter (Figure **77**) and most of the consumers pay €27-€45.

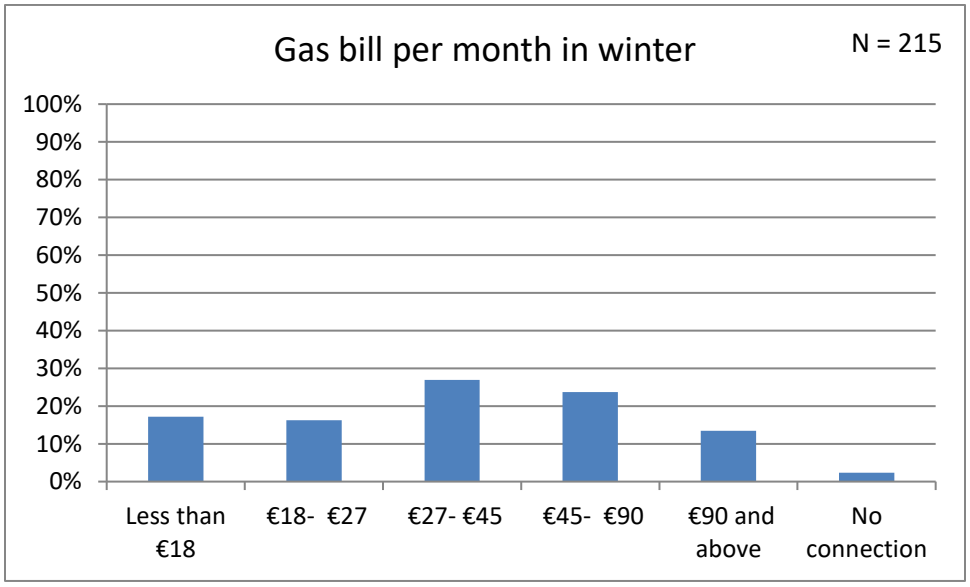

Figure 77 Gas bill per month in winter

4.9 Water

The city of Quetta is facing a problem of water scarcity, shortage and degrading of water level. Water and Sewerage Authority (WASA) Quetta is responsible for water distribution and sewage system. Water connections are provided in almost every part of Quetta but there in interruption in water supply due to that people need to call water tanker to fulfil their water demands. These tankers are operated by private companies and costs a lot compared to the water bill. Majority of the households uses tube well or bore well as main source of water (Figure 78). These tube wells are individual in most of the areas while in some areas one or more households share the water from one tube well connection whereas community tube wells are also found in some housing areas, such as, GOR colony, Survey 144 etc. where one or more community tube wells collect the water and store in HSR (High service reservoir) which is connected with houses to fulfil their water demands. Only 1% of the households use canes and water bottles to fetch and store the water since these houses also do not have any water connection or source and these houses were located in outskirts of Quetta city.

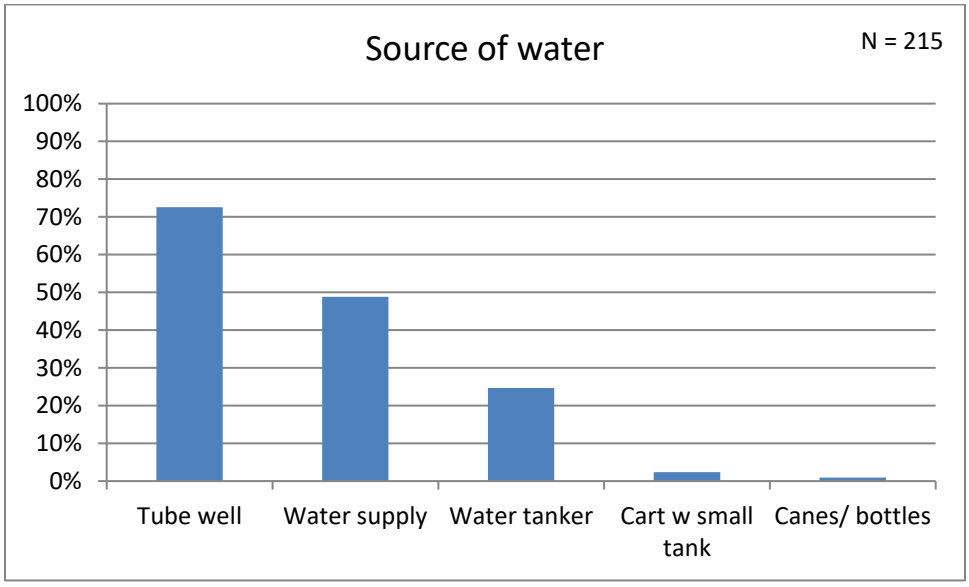

Figure 78 Source of water

Majority of households pay their water bills (Figure 79), these bills were not necessarily paid to WASA Quetta but in some areas they pay a fixed amount for the maintenance and operational cost of community/ combined tube well.

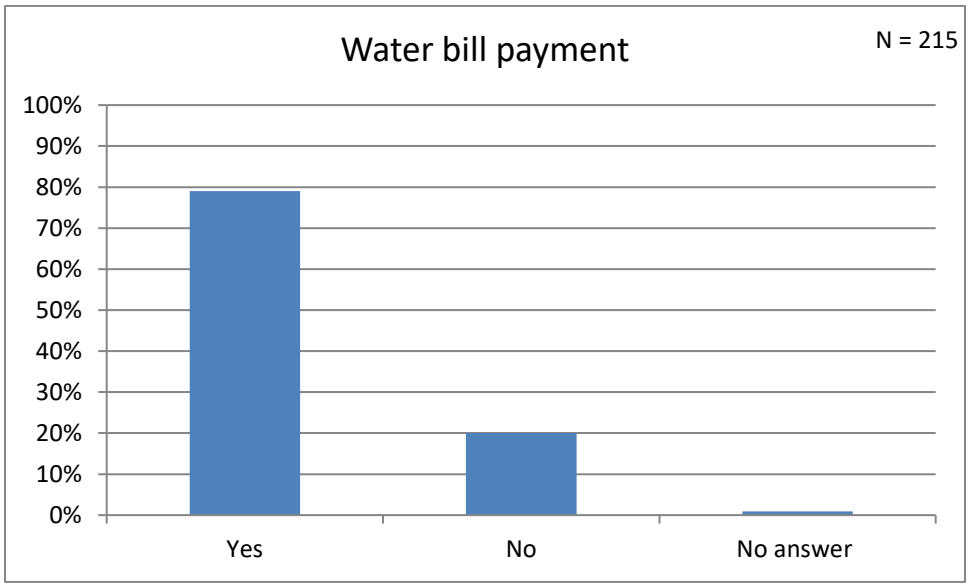

Figure 79 (Water bill payment)

27% of the households pay €9 or more for their monthly water consumption whereas 26% households pay up to €2.7 per month. It is possible that a household might spend more than €9 per month to fulfil their water needs in the areas where water tanker is also considered as source of water.

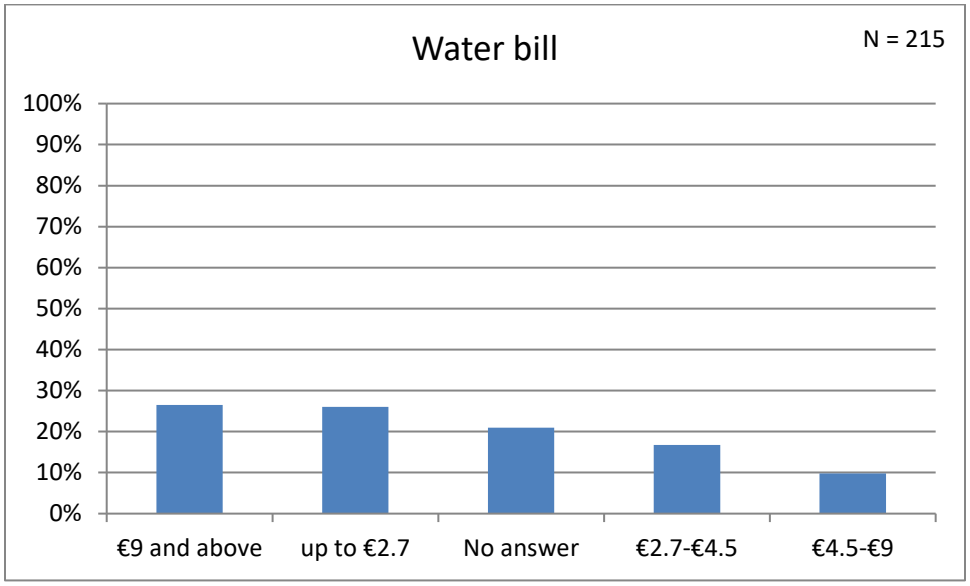

Figure 80 (Water bill)

The result (Figure **81**) shows that underground tank (UGT) is widely used for water storage; whereas in reality overhead tank (OHT) is more common. The reason behind this response can be the way

this question asked or understood by the respondents. As common perception is that UGT is used for water storage and OHT is used for day to day usage and demand. In many households stored water from UGT is pumped to OHT when there is interruption of water supply. There is more possibility that all the households with UGT also have OHT. Only 8% of the households also use Drum (water container) to store water, these household are mainly located in public housing, and the reason could be that the existing water tank may not be sufficient for daily water consumption and demand of the family.

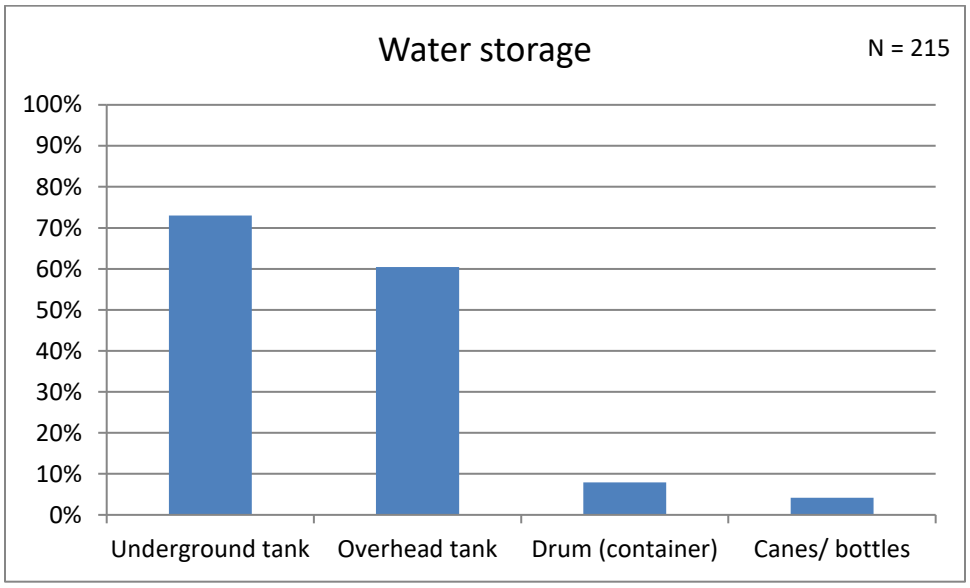

Figure 81 Water storage

4.10 Drainage & Waste disposal

Waste water is mostly drained into public sewers but few of the areas also use other means of drainage (Figure **82**). It is important to mention that water channels used to drain water are seasonal and built to drain the rain water coming to city from the mountains or areas with high altitude, most of these water channels are now used to drain waste water. These are normally called Nala (in Urdu) or Lora (in Pashto), city Nala which is also famous with the name of Habib Nala is one of the main water channel used for drainage. While there are other Nala (water channels) which are also used in other areas of Quetta to drain waste water, such as Baleli Nala at Airport/ Baleli road.

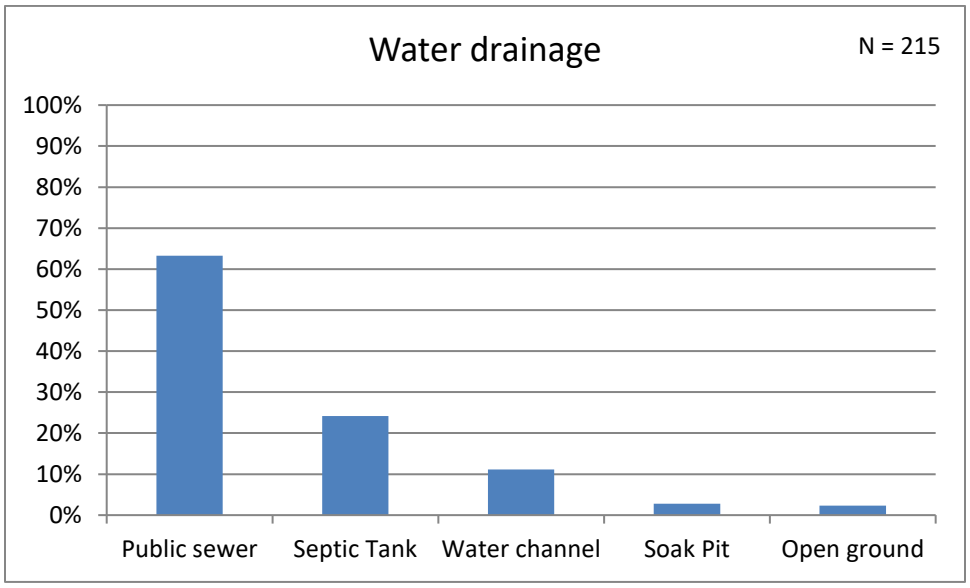

Figure 82 Water drainage

Solid waste is collected from House to house (H2H) from 40% of the households while rest use community bins, leave at disposal site, empty plot or at street/ road (Figure 83). It was found that even in some developed housing areas, i.e. Survey 144; people leave solid waste at empty plots and then burn it from time to time which then turn into small particle and spread around. The smoke produced during this process is harmful for human health.

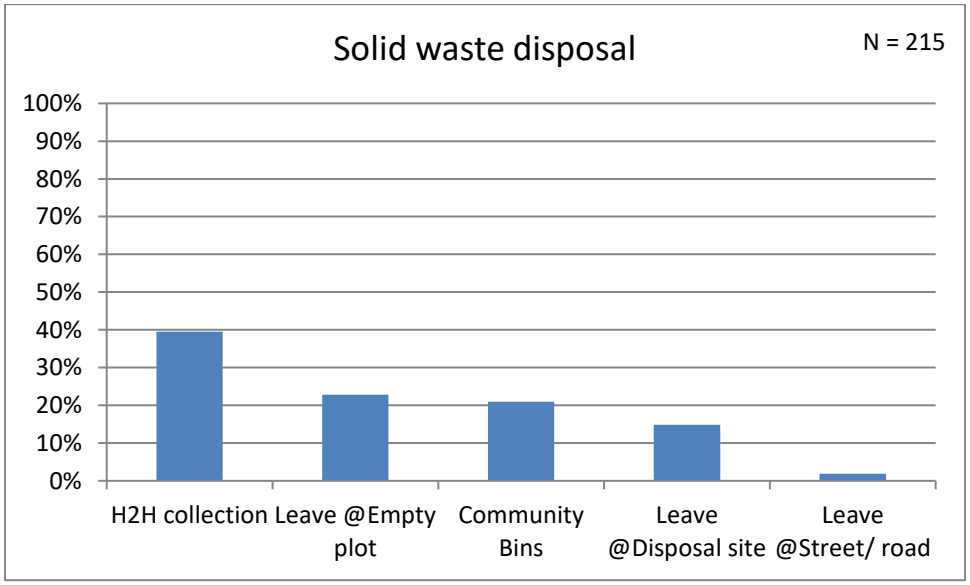

Figure 83 (Solid waste disposal)

5. Construction types

The most common structural systems (Figure **56**) found were; RCC frame, Brick masonry and Sundried bricks. These were further analysed to identify the common materials used for each structural system.

In total 139, 67 and 11 houses are constructed with RCC frame structure, brick masonry and sundried bricks respectively.

5.1 Walls

Exterior walls in RCC frame and brick masonry structures were mainly constructed of baked bricks (BB) with cement mortar while it was composed of sundried bricks and rammed earth in sundried brick structures (Figure **84**).

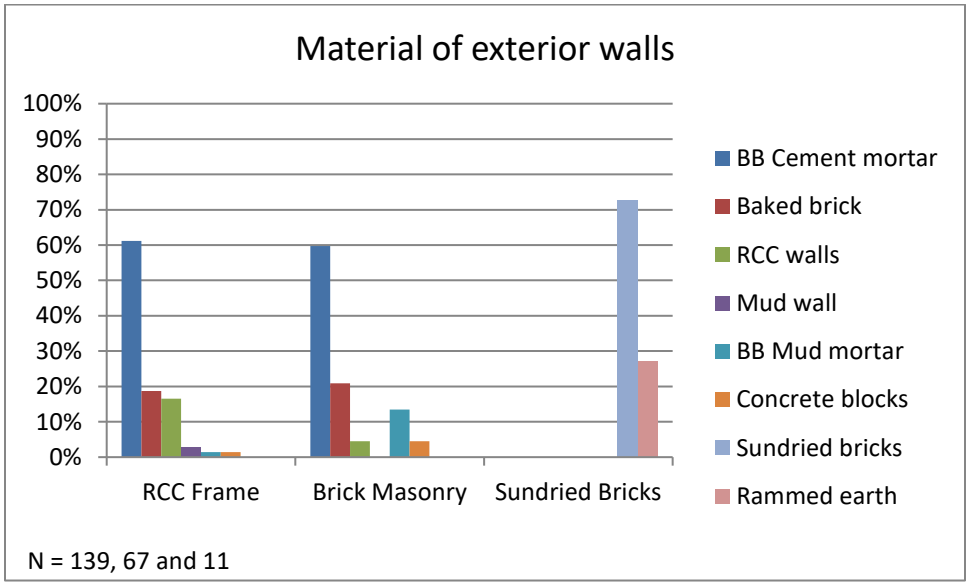

Figure 84 Material of exterior walls (construction types)

Exterior walls in RCC frame and brick masonry structures were mostly finished with paint and cement plaster whereas in sundried brick structures common finish was mud plaster and paint. The combination of one or more finishes is possible as multiple answers could be selected for this question.

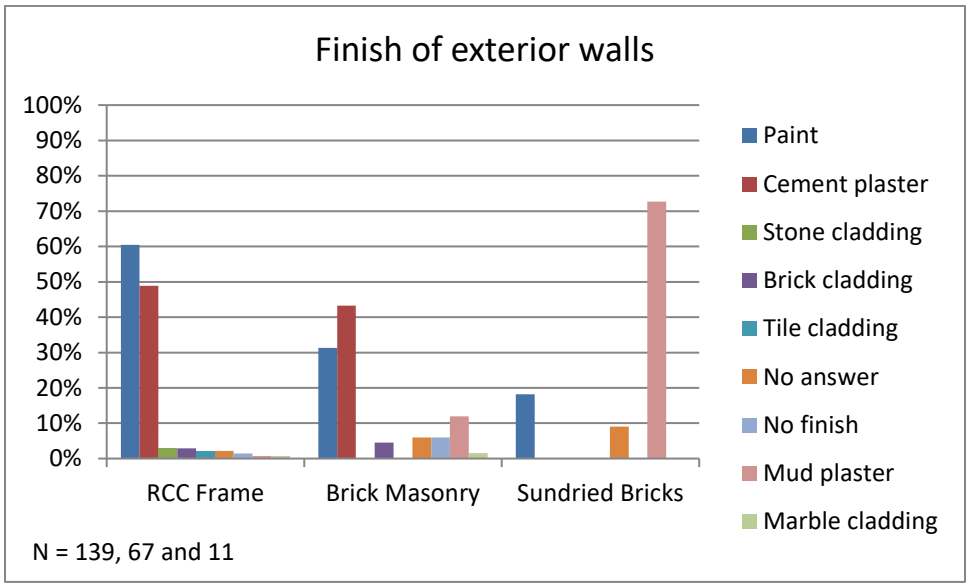

Figure 85 Finish of exterior walls (construction types)

Most common wall finish for RCC frame and brick masonry houses was paint and cement plaster and in sundried brick houses it was mud plaster and paint (Figure 86). More than one finish is also possible in interior walls as sometime different finish is applied at skirting, sill level and above sill level.

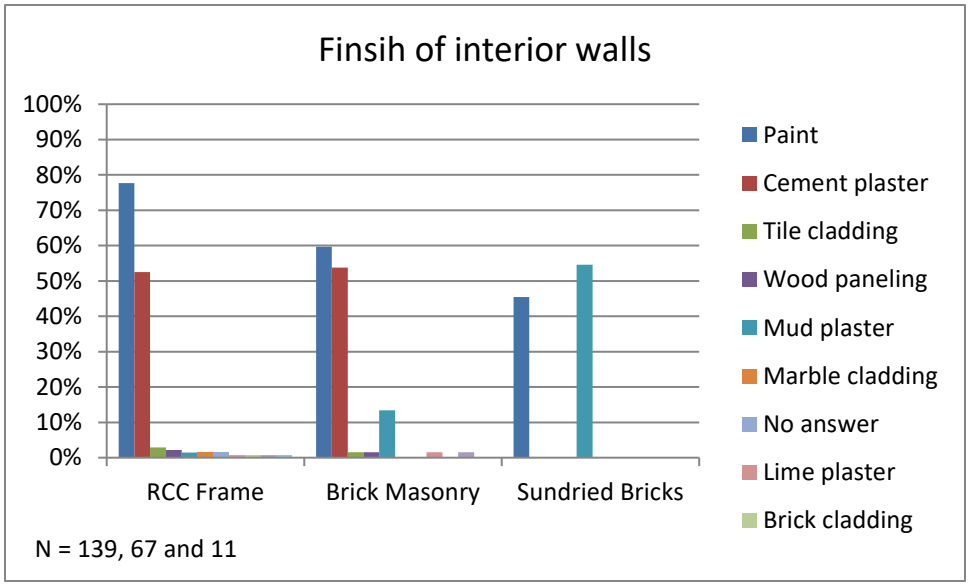

Figure 86 Finish of interior walls (construction types)

5.2 Floor

Plan cement concrete (PCC) is most commonly used in flooring of RCC and brick masonry houses while in sundried brick structures floor are made of earth/ sand/ mud, brick masonry as well as PCC (Figure **87**).

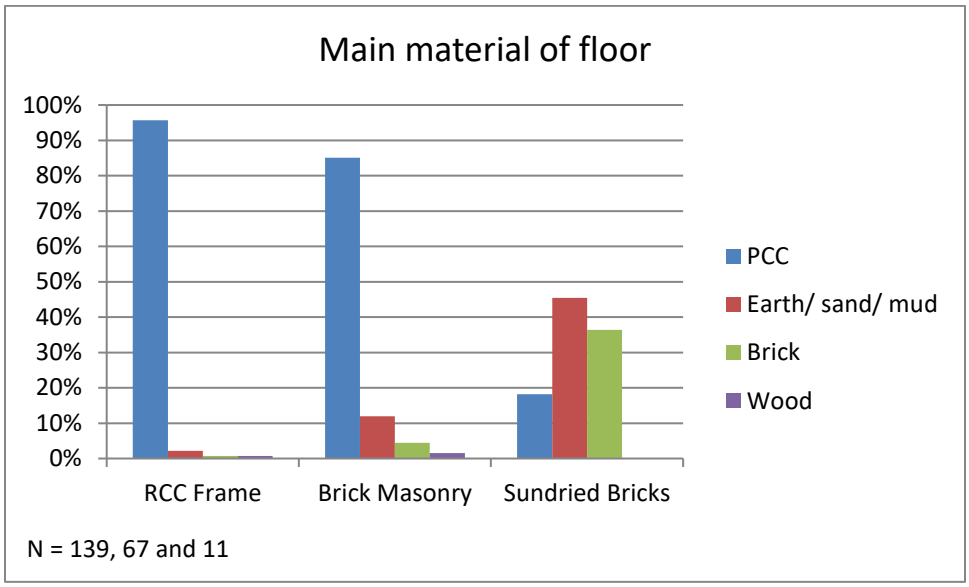

Figure 87 Main material of floor (construction types)

Multiple options were possible to select for floor finishing. PCC floor, carpet/ mats, marble, and ceramic tile are common finishes in houses with RCC structure. Carpet/ mats, PCC floor, terrazzo and mud floors were found in brick masonry houses while mud and brick floors were more common in sundried brick houses.

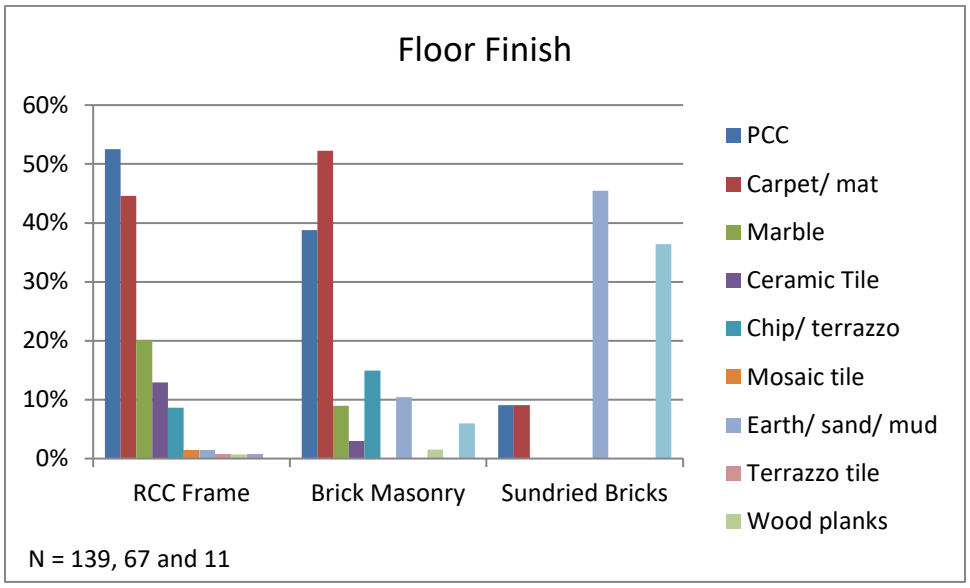

Figure 88 Floor finish (construction types)

5.3 Roof

The roof was analysed in terms of room framing, covering and falls ceiling for each construction type. In RCC construction roof framing is mainly made of RCC beams, RCC beams, girder/ T-iron and wooden beams with bamboos/ girders are used in brick masonry structures, and girder/ T-iron and wooden beams with bamboos/ girders are common roof framing materials in sundried brick houses (Figure 89).

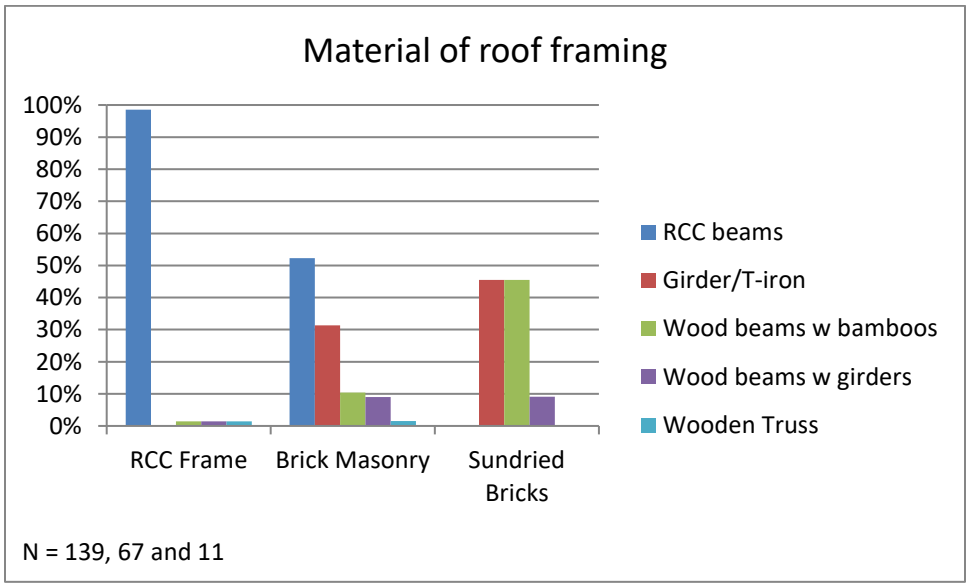

Figure 89 Material of roof framing (construction types)

RCC slab is the major roof covering used in RCC frame structures while RCC slab and burnt brick (terracotta) tile in brick masonry, and thatch/ palm/ bamboos and brunt brick (roof) tile is commonly used in sundried brick houses as roof covering (Figure **90**).

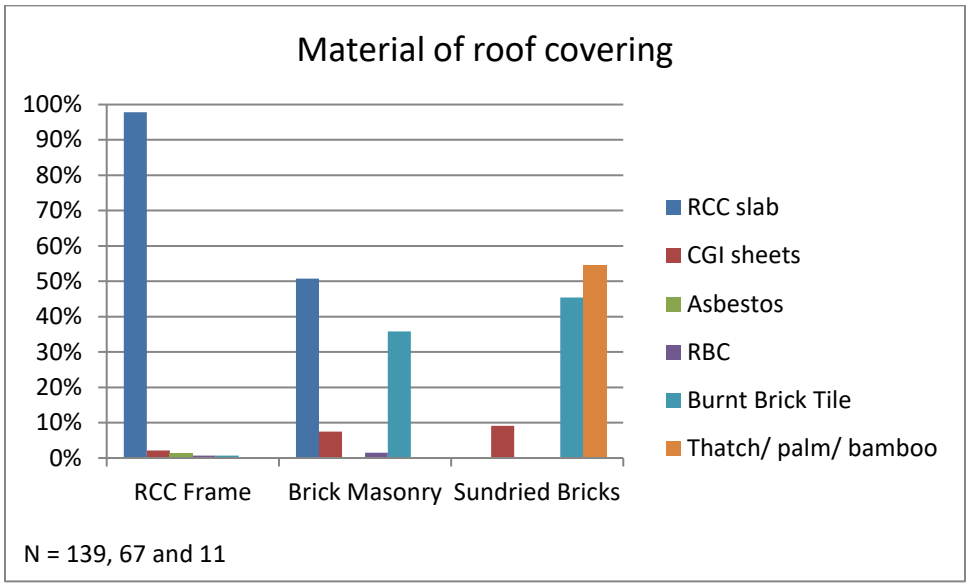

Figure 90 Material of roof covering (construction types)

Many houses had no false ceiling in all 3 construction types. Most common false ceiling material was gypsum in RCC and brick masonry houses whereas mud false ceiling was commonly used in sundried brick houses (Figure 91).

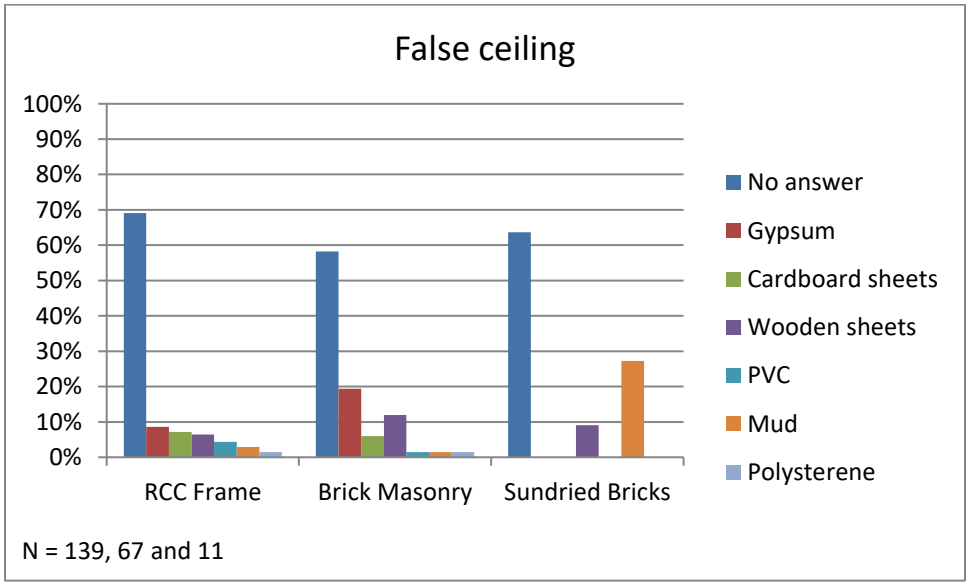

Figure 91 False ceiling (construction types)

5.4 Insulation

Insulation was not wide spread in Quetta, and only 4% of the houses insulated walls in RCC houses and 7% in brick masonry houses. No insulated was found in houses with sundried bricks (Figure **92**).

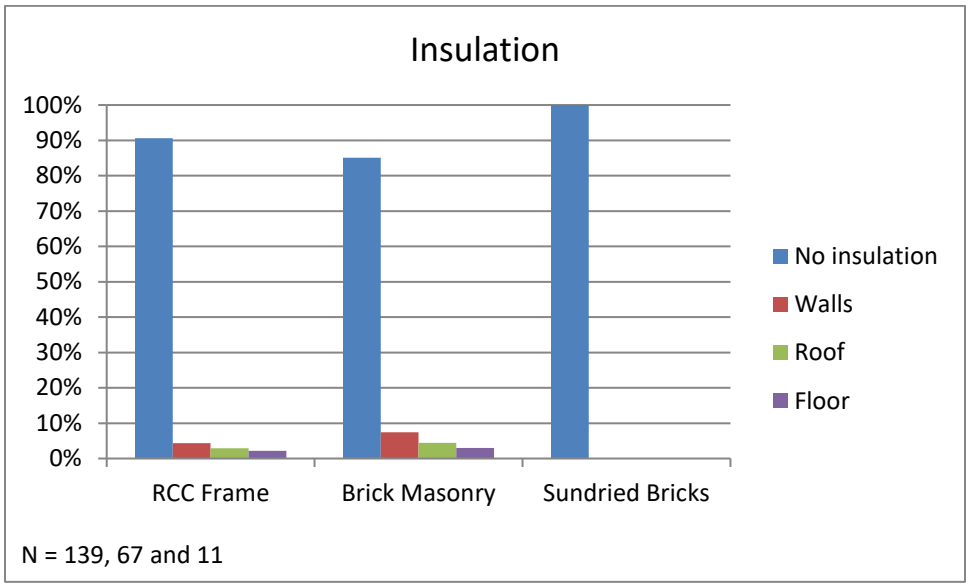

Figure 92 Insulation (construction types)

5.5 Window glazing

Single glazed windows were widely used in the houses of all 3 structural types (Figure **93**). Double glazed windows were mainly used in houses built during last 10-15 years.

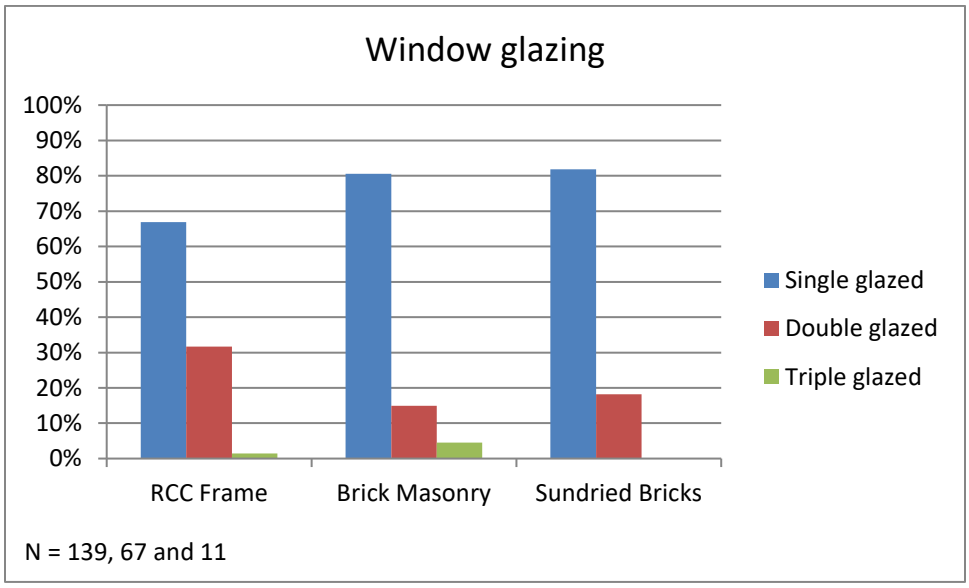

Figure 93 Window glazing (construction types)

5.6 Structural types

This section covers the construction materials and finishes of all three common structural types, i.e. RCC frame, brick masonry and sundried bricks.

5.6.1 RCC Frame Structure

Reinforced concrete frame structure is most commonly used structure type in Quetta. In this type of houses foundation, beams and columns are built of reinforced concrete while walls are filled with baked bricks using mortar (Table **6**).

Table 6 Material composition of houses with RCC frame structure

S. No.	Building part/ finish	Material composition
1.	Exterior walls	Baked brick with cement mortar (61%), baked bricks (19%), RCC walls (17%)
2.	Finish of exterior walls	Paint (60%), cement plaster (49%)
3.	Finish of interior walls	Paint (78%), cement plaster (53%)
4.	Material of floor	PCC (96%)
5.	Floor finish	PCC (53%), carpet/ mat (45%), marble (20%), ceramic tile (13%), chip/terrazzo (9%)
6.	Roof framing	RCC beams (99%)
7.	Roof covering	RCC slab (98%)
8.	False ceiling	Gypsum (9%), card board sheets (7%), wooden sheets (6%), PVC (4%)
9.	Window glazing	Single glazed (67%), double glazed (32%)

5.6.2 Brick masonry

The composition of houses with brick masonry structure is given in Table 7.

Table 7 Material composition of houses with brick masonry structure

S. No.	Building part/ finish	Material composition
1.	Exterior walls	Baked brick with cement mortar (60%), baked bricks (21%), baked brick with mud mortar (13%)
2.	Finish of exterior walls	Paint (31%), cement plaster (43%), mud plaster (12%)
3.	Finish of interior walls	Paint (60%), cement plaster (54%), mud plaster (13%)
4.	Material of floor	PCC (85%), earth/sand/mud (12%), Brick (4%)
5.	Floor finish	Carpet/ mat (52%), PCC (39%), chip/terrazzo (15%), earth/sand/mud (10%), marble (9%), brick (6%),
6.	Roof framing	RCC beams (52%), Girder/T-iron (31%), wooden beams with bamboos (10%), wooden beams with girders (9%)
7.	Roof covering	RCC slab (51%), burnt brick/ roof tile (36%)
8.	False ceiling	Gypsum (19%), wooden sheets (12%), card board sheets (6%),
9.	Window glazing	Single glazed (81%), double glazed (15%)

5.6.2 Sundried bricks

The composition of houses with sundried brick structure is given in Table **8**.

Table 8 Material composition of houses with sundried bricks structure

S. No.	Building part/ finish	Material composition
1.	Exterior walls	Sundried brick (73%), rammed earth (27%)
2.	Finish of exterior walls	Mud plaster (73%), Paint (18%)
3.	Finish of interior walls	Mud plaster (55%), Paint (45%)
4.	Material of floor	Earth/sand/mud (45%), Brick (36%), PCC (18%)
5.	Floor finish	Earth/sand/mud (45%), brick (36%), carpet/ mat (9%), PCC (9%)
6.	Roof framing	Girder/T-iron (45%), wooden beams with bamboos (45%), wooden beams with girders (9%)
7.	Roof covering	Thatch/palm/bamboo (55%), burnt brick/ roof tile (45%), CGI sheets (9%)
8.	False ceiling	Mud (27%), wooden sheets (9%),
9.	Window glazing	Single glazed (82%), double glazed (18%)

6. Climate of Quetta

Quetta has dry and arid climate with hot summer and mild to extreme cold in winter. The city of Quetta lies out of monsoon region; however, it receives snowfall mostly during the months of December, January, and February (P&D GoB, 2011). It is important to add that the climate of Quetta has significant variations during winter and summer (Mahar, 2017). Between 2009-2016, the average recorded temperature in summer were 31 ºC and in winter 7 ºC (Online, 2017). The extreme recorded temperatures in Quetta are -18.3 ºC in 1970 and 42 ºC in 1998 (PMD, 2018). It is observed that in the extreme climates there is fairly high demand for heating and cooling the buildings. Figures 4-7 provide more information about the climate of Quetta; the results are based on a TMY file of the years 1981-2016.

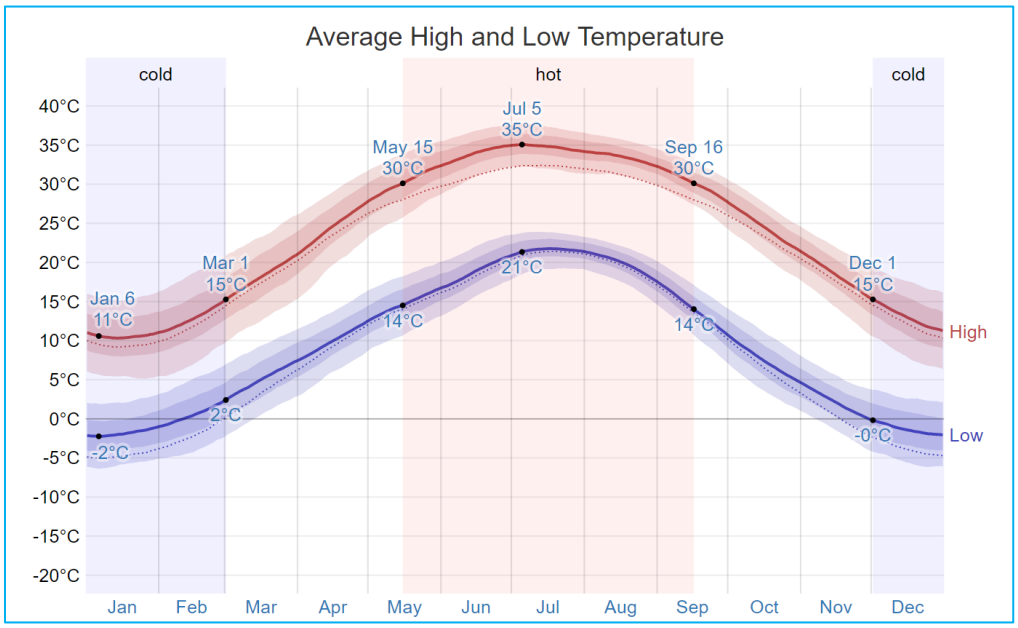

Figure 94 Average high and low temperature
Source: Weather spark

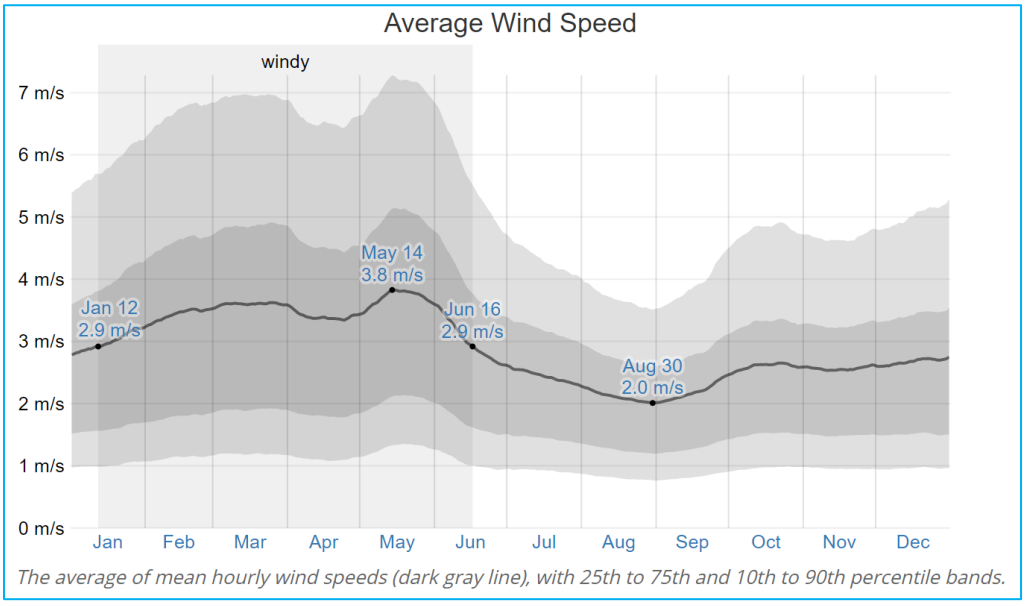

Figure 95 Average wind speed
Source: Weather spark

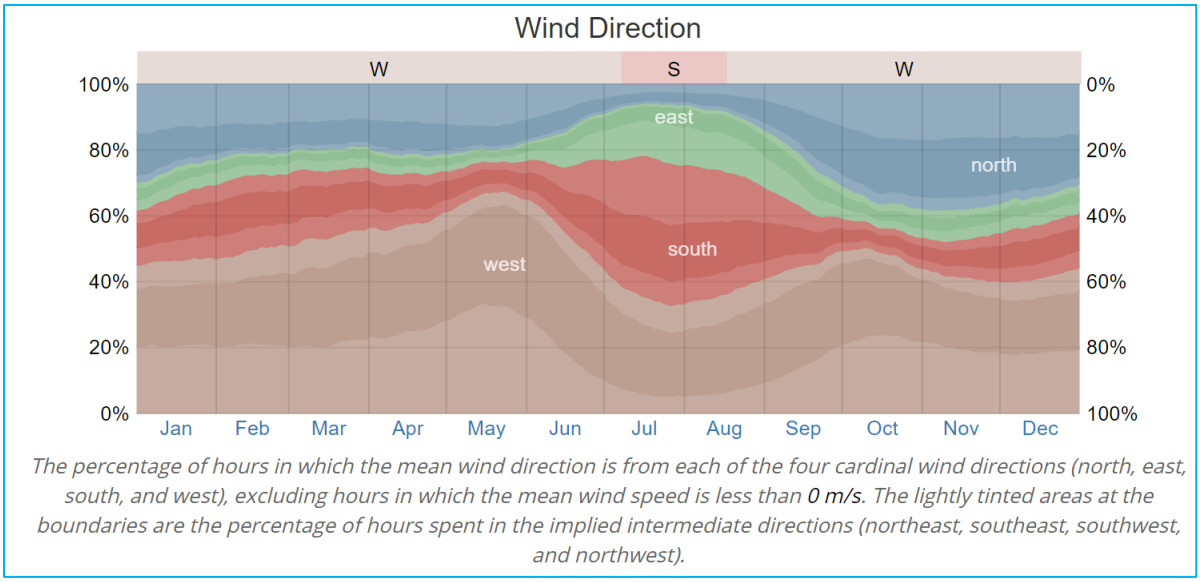

Figure 96 Wind direction
Source: Weather spark

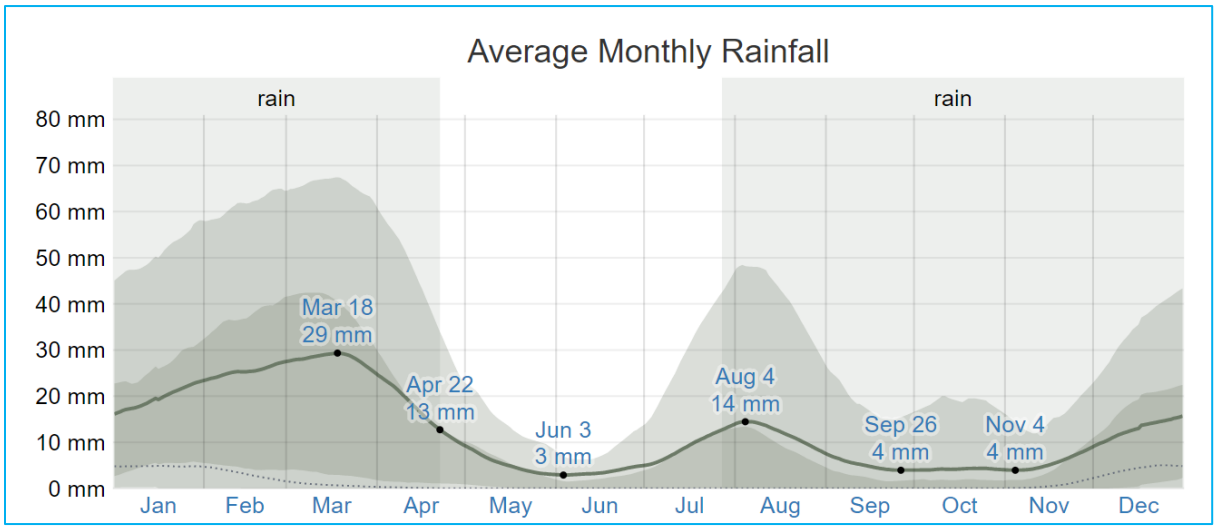

Figure 97 Average monthly rainfall
Source: Weather spark

7. Energy & water systems

Energy and water are essential needs of a household. This section will provide an overview of the existing situation of energy, water and available systems for both in Quetta. Energy is further divided into electricity and natural gas.

7.1. Electricity

Quetta Electric Supply Company (QESCO) is the only electricity distribution company in Quetta. The company also supplies electricity to whole Balochistan province except few areas of Lasbela district which are covered by K-Electric (K-Electric, 2017). QESCO get the electricity from national grid, generated in power plants around the country except in 3 districts of Makran division where electricity is supplied/ imported from Iran (BBC Urdu, 2017).

The electricity price per kWh depends on the usage of electricity, i.e. consumer uses up to 50 units (kWh) per month pay 4 rupees (Rs.) per kWh, and if consumption exceeds 50 units; 1-100 units/ per month then they need to pay Rs. 12.5 per kWh (QESCO, 2015). Similarly, the tariff increases for the users with higher consumption of electricity. These prices are not fixed and can vary depending the charges/ cost of fuel.

According to data provided in 2016 by MIS (Management Information System) department QESCO (Table 9) there are 181, 861 domestic consumers in Quetta and load shedding hours vary from 4-6h/day in winter to 6-8h/day in summer. Domestic sector also consumes the largest part of electricity (73.9%) consumed over all (Figure 98).

Table 9 Overview of electricity in Quetta

1.	No. of domestic consumers in Quetta	181, 861
2.	Source of electricity	11KV transmission line
3.	Alternative energy source	Solar
4.	Average load shedding hours in winter	4-6 hours/day (2160 hours/year)
5.	Average load shedding hours in summer	6-8 hours/day (2880 hours/year)
6.	Average demand of domestic consumers	429, 529 MW per month 5, 154, 348 MW per year
7.	Usage of domestic consumers	342, 850 MW per month 4, 114, 200 MW per year
8.	Short fall and gap between demand & supply	9, 705.06 MW per month

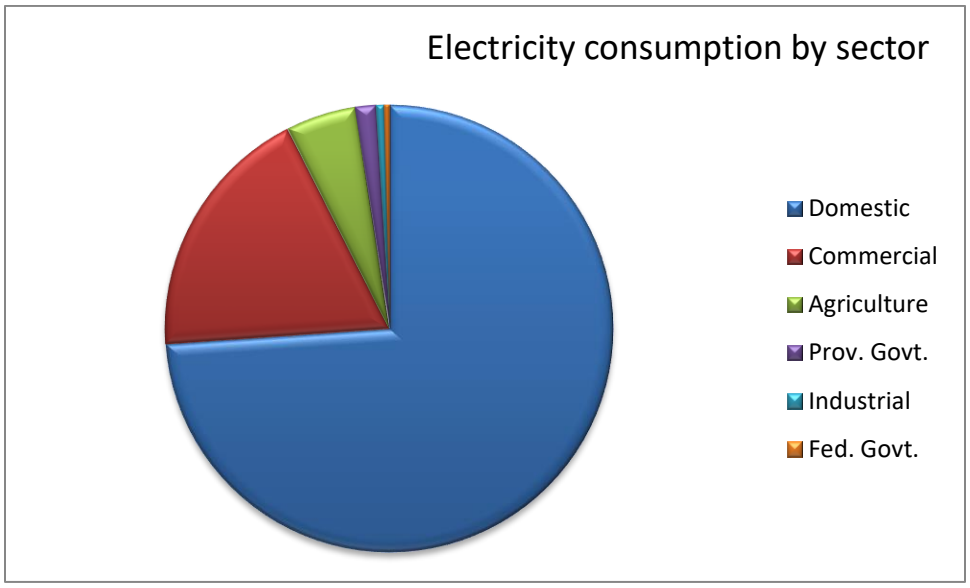

Figure 98 Electricity consumption by sector

7.1.1 Electric power plants in Quetta

Currently there are two power generation stations in Quetta and both are operational. Both power stations use natural gas to produce electricity.

- Quetta Thermal Power Plant: This plant was commission by Mitsubishi Japan in 1994. The total capacity of this plant is 35 MW and it consist 1 unit. The project was and initiative of WAPDA (Water & Power Development Authority) and it is currently being operated by PEPCO (Pakistan Electric Power Company) (GEO, 2010).
- Habibullah Coastal Power Company (HCPC) Private Limited: This power plant is located near Klli Almas, Shaikh Manda, Airport road, Quetta. The plant started its operations in September 1999. The total capacity of this plant is 140 MW and it consist 4 units (GEO, 2010) (NTDC, 2015).

7.1.2 Future electricity generation projects in Quetta

Inter-teck Kuwait Investment Authority and provincial government of Balochistan signed MoU to set up a solar energy power plant in Quetta, Balochistan to meet the energy demands of the

provincial capital. The plant will be started at 50 MW and will be gradually upgraded till 500 MW (Business Recorder, 2016).

On 15th December 2013, Government of Balochistan (GoB) and Mutual Agreement with CK Solar, Korea for the establishment of 300 MW Solar Power Plant at Quetta. The project would cost USD 700 Million and GoB allocated 1500 acres of land for the project near Kuchlak, District Quetta. According to agreement the project will be started in December 2014 and completed in 2017 (GoB, 2013).

7.1.3 Renewable energy potential

According to American National Renewable Energy Laboratory (NREL) Quetta and its neighbouring areas receive average solar global isolation of 6.5-7.5 kWh/m^2/day (Figure **99**). It shows that there is great potential of solar energy in Quetta and its neighbouring areas. Provincial government installed solar street lights which are mostly not functioning due to battery fault or stolen. However, the usage of solar PV is increasing in the city especially during load shedding hours and some people prefer to use solar energy instead of installing UPS (Uninterrupted Power Supply).

There is fair potential to generate wind power in Quetta and its neighbouring areas and the wind power density at 50m is 300-400 W/m^2 with a wind speed of 6.2-6.9 m/s (NREL, 2007). IDSP (Institute for Development Studies & Practices) a non-government organisation (NGO) installed windmill, solar panels, solar water heaters and biogas plant to fulfil the energy demand of IDSP University of Community Development campus located at Hanna road, Quetta. Balochistan University of Information Technology, Engineering & Management Sciences (BUITEMS) Quetta installed a wind tunnel on Takatu Mountain to generate wind power; project was never stopped due to the change of university administration. Windmill (fans) were also installed on the roof of Department of Architecture's Building (Hall-I), which were operational in the beginning and was considered a good success. Batteries and installations are still present, but project is no more functional due to lack of maintenance.

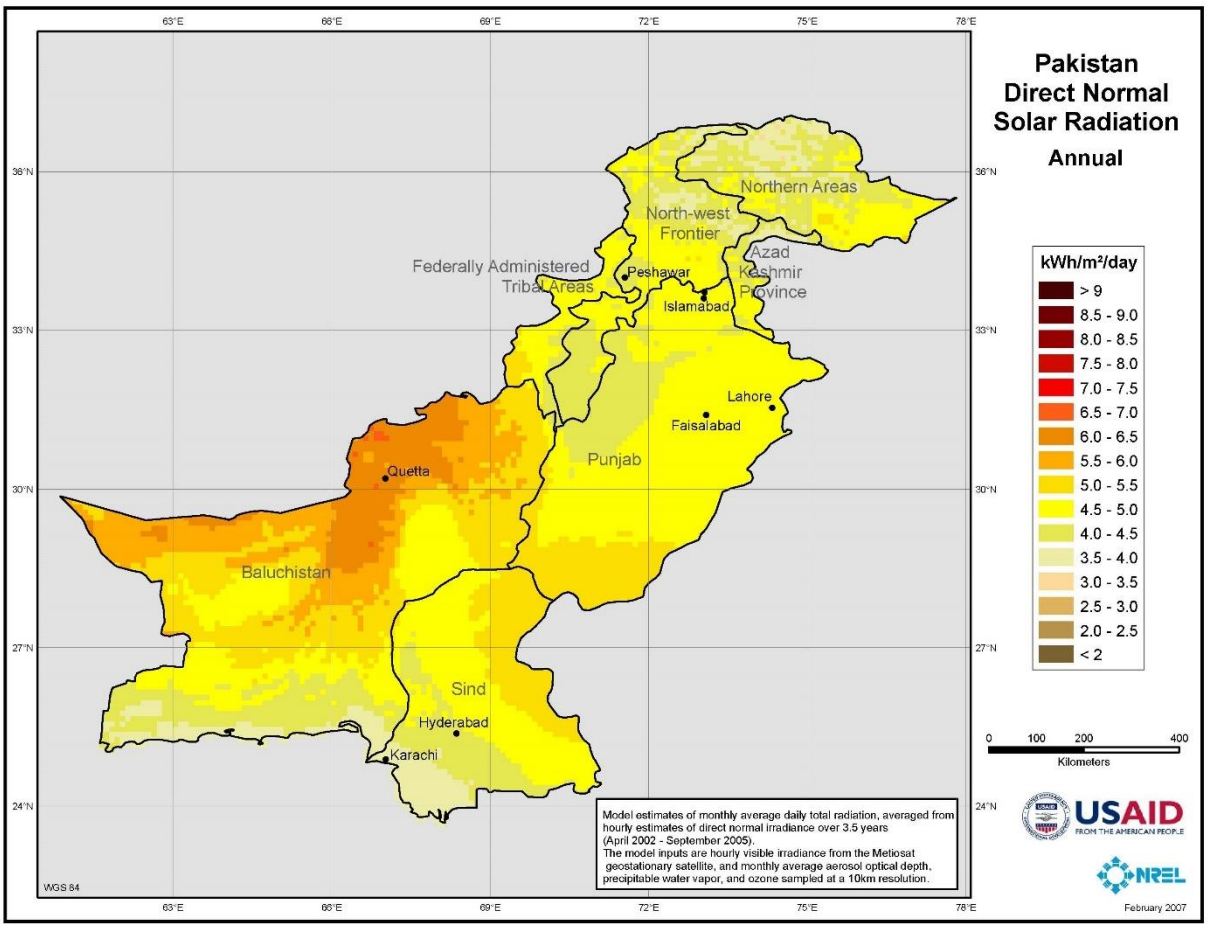

Figure 99 Direct Normal Solar Radiation (Annual) Map of Pakistan

(Source: NREL, 2007)

7.2 Natural Gas

Sui Southern Gas Company (SSGC) is responsible for the transmission and distribution of natural gas in southern part of Pakistan, including Balochistan and Sindh province. SSGC is also engaged in the installation of high pressure transmission and low-pressure distribution system. The billing tariff for domestic consumers is listed in Table 10 (SSGC, 2016).

Table 10 Billing tariff of SSGC for domestic consumers

Usage	Sale price in Rs./ MMBTU
Up to 100 m^3 per month	110
Up to 300 m^3 per month	220
Over 300 m^3 per month	600
Minimum charges: Rs. 148.50 per month	

Natural gas is mainly used for cooking, heating (rooms+ water) and also for lighting in some houses (during load shedding hours). According to 1998 population census, 77.53% of housing units in Quetta use gas for cooking (PBS, 1998). The citizens of Quetta and Balochistan experience very low gas pressure especially in winter and also suspension of gas in different areas of the city which highly affects the daily life during cold weather (B Voices, 2016) (The News, 2015). The overall consumption of gas in Balochistan (7%) is lower than the production (19%) during 2012-16 (ESP, 2015) and still a large of province has no supply of natural gas (B Express, 2016) (The Express Tribune, 2014).

7.3 Water

This section covers the existing water supply system in Quetta and the problem of water shortage in Quetta Valley.

7.3.1 Water Supply

Water & Sanitation Authority (WASA) was established in 1986 with a mandate of providing water and sanitation services to the urban areas of Balochistan having a population more than 100, 000. In 2004-5 its mandate was revised and limited to the provision of water and sanitation services to the urban areas of Quetta. WASA is responsible for the water storage, filtration, treatment, distribution and water supply in Quetta city. It uses both sources of water; i.e. ground and surface water and serves around 62 thousand domestic consumers. It covers 70% of the city and serving 1.5 million people (PWON, 2012). The sewage coverage was12.5% in 2012, which is also due to the use of seasonal water channels to drain off the sewerage. Some additional facts about WASA Quetta are stated in Table 11.

Table 11 WASA Quetta

Average monthly water consumption per household	49.6 m^3
Per capita consumption	59 litres/ day
Average unit production cost	RS. 0.75/ m^3
Annual water production	1, 204.75 million m^3
Water bill per month	Rs. 125-Rs. 250 (€1.1-€2.2)
New connection charges (residential)	Rs. 1000 (€8.9)
Average availability of water	1 hour/ day
Total distribution pipes (water supply)	1900 km
Total sewer pipes	82 km

As of 2015, 95% of the households have access to tap water (PESA, 2015). It is observed during housing survey that still large number of household use Tube well/ Borehole or Water tankers to fulfil their water demand (Figure 78). One of the reasons is interruption of water supply in many areas of the city.

7.3.2 Water shortage

Quetta is located in the arid region and water sources are limited. Groundwater depletion is rapid due to indiscriminate water mining, mismanagement, unplanned and inefficient use of water sources. The water shortage occurred due to increased number of population, refugee migration from Afghanistan, increased number of orchards, vegetable and crop cultivation and substantially reduced recharge due to de-vegetation, deforestation and construction of housing on recharge areas. The city of Quetta is growing rapidly while the water resources are limited and cannot sustain the demand existing population, agriculture, industry, and nature for long. (IUCN, 2011). Quetta falls in Pishin Lora Basin (PLB) which is located at the border region of Balochistan province, Pakistan and Kandahar province, Afghanistan (Z. Sagintayev, 2008).

The water supply pipelines system of water supply is inefficient and line losses due to leaky pipes are around 40 per cent. Galvanized iron (GI) and steel pipes are used which are sensitive to

corrosion, freezing and thawing in the cold winter season (IUCN, 2011). During 2010-11, WASA Quetta received 14, 400 complaints related to water and sewerage services and 6, 480 broken water supply pipes were repaired (PWON, 2012).

Due to interruption in water supply, more tube well/ borehole connections being set up in many areas of Quetta which also increased the use of water. This interruption made access to drinking water more challenging and in many areas, households fulfil their water demands by calling water tanker which cost extra expenses. The water connections are provided without the installation of water meters and billing is based on the size of water pipe rather than actual usage/ consumption of water.

According to (Kazmi AH, 2005) there are two aquifers in the Quetta Valley: A bedrock aquifer and an unconsolidated alluvial aquifer. The first one contains the limestone of the Chiltan and Shirinab formations and conglomerates of the Urak formation; and it is recharged in the surrounding mountain areas where these formations are exposed. The second one (alluvial aquifer) contains sand, gravel, and silt deposits. It is also the main aquifer and recharged from infiltration of precipitation, inflow, and runoff from the bedrock aquifer.

Groundwater decline in Quetta was first noticed in 1989 when decline of 0.25m per year was observed (WAPDA, 2001). The ground water monitoring system was expanded in 1987 and at present WASA maintains ten automatic level recorders and several dozen monitoring wells. During 1990s decline of water level around 0.23-1.09 m per year was recorded in some parts of Quetta (Nguyen L, 2007).

8. Sewage systems

Beside water supply, WASA Quetta is also responsible to initiate and maintain the continuous planning and development process of sewerage and sanitation in Quetta (GoB, 2017). The main purpose of sewage disposal is the sanitary removal of human and industrial waste. A sewage system includes collection, treatment, and disposal; collection of waste water, its purification to reduce the pollution effects and transfer of waste effluent back to ecological cycle (MPQ).

The problem of sewage disposal became more serious due to increasing population. The existing sewage pipelines are not sufficient to handle the existing and growing flow of waste due to increased water consumption and installation of plumbing fixtures. There is no regulation in Quetta which involves permission for the installations of plumbing units and fixtures. In some areas the waste water is drained in seasonal water channel (Lora).

The existing situation of sewerage and sanitation is very poor (TBP, 2017). The situation gets worst after rainfall and snowfall when waste water over flow on the streets and roads of the city. Making it difficult for people to walk and drive on roads and increasing the risk for spreading several diseases. Many areas of the city look flooded after continuous or heavy rain and the water enters into houses, shops and markets which make every business more challenging (DAWN, 2015).

9. Discussion and key findings

The reports provide an overview of the conditions and characteristics of existing housing stock. It further discusses the climate condition, and infrastructure of energy, water and waste systems in Quetta, Pakistan. The data collection in several areas of Quetta was not an easy task and it took more time and energy to gather all such information and complete the surveys in various residential areas. This report creates a start point for the PhD research mentioned in Preface and will also be helpful for future researchers to collect data in conflict prone areas such as Quetta. The results provide valuable insights to understand the housing construction details, techniques, materials, and practices used in Quetta. The presented results are based on the survey of 215 houses and review of several documents, literature and data collected from several institutions and authorities.

In the beginning the first challenge was to identify the safe areas for housing survey. As not all the residential areas of Quetta are safe or unsafe for the people of all ethnic group(s). Also, the information available or collected by different organizations vary a lot. Internet and its usage is getting popular in Pakistan and in recent years several surveys were conducted online. In this way, one can easily reach many respondents from various walks of life, social, cultural, religious and

ethnic backgrounds to collect the data. That's why safety survey was conducted online, and it was very helpful to understand the safety in the city of Quetta as perceived by its residents.

The second step of this research was housing survey which was properly planned and executed with the help of the residents, students and professionals. And the third step for this report was to collect data from several organizations and departments to understand the existing facilities and infrastructure of water, energy and waste systems in Quetta. The key findings of this study are mentioned as following:

- The residential areas in the north of Quetta city are considered safer to live and visit while residential areas in south are mainly considered unsafe. Due to unstable law and order situation and occurrence of frequent terror attacks in the south of Quetta.
- The planned housing developments and public housing areas are mainly considered safe.
- Quetta is a multi-ethnic city. Some residential areas consist the population of one or more ethnic groups while other areas have mixed population.
- People generally know and identify the residential area(s) with its link to the major roads, highways, or bypass.
- Internet is more popular among youth and working class.
- The involvement of residents who can speak the local languages and have sufficient knowledge of the subject can be very helpful for data collection.
- As per housing survey, majority of the houses in Quetta were constructed during last 4 decades and most of them were constructed in last 2 decades.
- The average household size out of 215 houses is 9.9 persons per house.
- The most common plot sizes found in this survey were between 100-200 m^2.
- The average room occupancy is 2.18 persons per room.
- Majority of the houses were not designed by any architect or qualified professional.
- Insulation is very rare in Quetta. Majority of the people have no or less knowledge about the insulation.
- Use of marble and tile is common as floor finish which helps to provide comfortable temperature in summer, but floor get very cold in winter. Carpets and mats are used to cover the floor in winter to reduce the cold effect of the floor.

- Single glazed windows are very common in Quetta while double glazed windows are introduced in recent years.
- Rooms are heated by using individual heaters in all rooms. Central heating system is installed in some houses (8%). Yet, it is not more favourable due to lack of technical and maintenance staff in Quetta.
- Gas is the main source of heating and it is also used for cooking meals.
- Electricity outage is common in both winter and summer which varies from 4-8h per day.
- There is interruption of water supply in many areas of the city and during interruption period the residents rely on water tankers which costs a lot more. Using ground water is very common in many areas where water level is not too low.
- Solid waste disposal and drainage system need to be improved for the health and hygiene of the residents in many areas of the city.
- There are three common housing construction types and structural systems in Quetta, RRC frame structure, Brick masonry and Sundried bricks.
- The materials of roofs, floors, walls and finishes in all three construction systems vary which is discussed in detail in section 5.6.
- The climate of Quetta need contextual design for such settings to provide improved thermal comfort to the residents in both seasons.
- Electricity prices vary depending on the total consumption. The prices are also based on the cost of the electricity generation and the means or fuel used for the electricity generation.
- Domestic sector in Quetta is the largest consumer of electricity by using 74% of the total electricity. There are 2 electric power plants in Quetta and there are some projects in the pipeline for future electricity generation which includes renewable energy sources.
- There is great potential of renewable energy generation in Quetta, especially solar energy as the city and its nearby areas receive average solar global isolation of 6.5-7.5 $kWh/m^2/day$.
- Water supply and drainage system need to be upgraded and improved for the continuous water supply to all areas of the city. The areas near Cantonment, Samungli road, airport

road etc. drain their water in rainwater channels, which are open at many places and cause several problems by spreading germs.

- Water shortage is common and over growing problem in Pakistan and several other countries. In Quetta, ground water reduction is faster than many other cities of the country which will create sever water crisis in future.

10. Conclusion

Housing and residential facilities play an important role in our lives. A good housing and living facility improves our mental and physical health and well-being. Provision of better houses and housing facility remain a challenge in many developing countries including Pakistan. There is shortage of millions of houses in Pakistan, on the other hand the existing houses don not provide comfortable living conditions to the residents. Climatic conditions cannot be ignored while designing a house, especially in the context of Quetta.

The results show that majority of the houses in Quetta are not designed by any qualified professional. Use of single glazed windows, and active systems for heating and cooling is not efficient and affordable. Insulation is not commonly used, and people have insufficient knowledge about the benefits of insulation and its usage. Electricity crisis severely disturbs everyday life and residents are unable to enjoy their time and sleep in their houses for several hours. There is a need to properly design the houses to gain more use of passive design techniques and acquiring comfort by natural ventilation in summer and solar gain by winter to reduce the usage of energy and effectively gain the thermal comfort in the houses. Using alternative materials and insulation may also help to improve the comfort and reduce the discomfort hours. The energy, water and sewage system need to be improved and upgraded according to the over growing demands of the residents.

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ISBN 978-2-930909-11-0

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ISBN 978-2-930909-11-0
9 782930 909110